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SEPTEMBER 1988
TASK NO. 27
VOLUME II - APPENDICES

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HAZARDOUS WASTE LAND DISPOSAL FACILITY
ASSESSMENT

CONTRACT NO. DAAK11-84-D-0017

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Rocky Mountain Arsenal Information Center Commerce City, Colorado

EBASCO SERVICES INCORPORATED

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Prepared for:

U.S. ARMY PROGRAM MANAGER'S OFFICE FOR ROCKY MOUNTAIN ARSENAL CONTAMINATION CLEANUP

Rocky Mountain Arsenal Information Center Commerce City, Colorado

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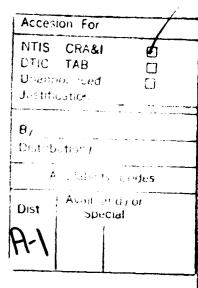


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APPENDIX I

WASTE CHARACTERIZATION

I.O WASTE CHARACTERIZATION

I.1 PURPOSE

The waste characterization chapter will address information needs for the land disposal facility concept design. These information needs are waste volume, waste type, waste form, chemical and physical properties of wastes at RMA, and waste location. The RMA waste estimates were based on borings and historic data in support of calculations using best engineering judgment. These estimates are a synthesis of reportedly conservative volume estimates from earlier studies of RMA and other estimates developed from the ongoing investigations of RMA's potentially contaminated sites, spill areas, and buildings.

The waste volumes were used to size the facility. The waste volumes were described by waste types and waste forms. This information was used in the evaluation of the land disposal facility's waste cell concept designs. Chemical and physical properties and locations of RMA wastes were factors in waste control design criteria, barrier system selection, facility siting, waste placement operations, and support facility requirements. These factors will be described in later chapters.

1.2 WASTE CHARACTERIZATION METHODOLOGY

The waste characterization methodology was based on a literature review and contact with current investigators to estimate RMA wastes of all contaminant types. RMA waste estimates were developed from a review of more than 100 applicable documents estimating quantities of potentially contaminated materials such as soil and building debris. No liquid wastes were considered in the current estimate due to regulatory bans on liquid waste disposal in land disposal facilities from the 1984 amendment to the Resource Conservation and Recovery Act (RCRA).

For the purposes of this task, all liquid wastes were assumed to be treated to a solid residue. Waste volume estimates included an allowance for liquid waste treatment residues.

Previous studies identified 165 sites that were investigated for potential chemical contamination, and 88 sites were identified as potentially contaminated. In addition to these previously identified contaminated sites, investigations of other areas of RMA were conducted. These investigations were part of remedial investigations (RIs) for CERCLA (ESE, 1986a). All contaminated sites will be summarized by section number, with a current contaminated materials estimate for each numbered site as well as building debris estimates by RMA section as appropriate.

Previous waste estimate studies, such as the the Decontamination Assessment of Land and Facilities at RMA (DALF)(RMACCPMT, 1984/RIC 84034R01), identified three types of potentially contaminated waste: hazardous and toxic materials, unexploded ordnance (UXO), and materials exposed to chemical warfare agents. These waste types will be described as to their importance to waste processing, hauling, and disposal operations.

The decontamination of all contaminated sites at RMA will generate both solid wastes and some liquid wastes (i.e., decontamination water or leachate). The liquid waste, as stated earlier, will not be disposed at the proposed land disposal facility. The liquid could be treated in a leachate treatment or other liquid treatment facility, and the solid residues subsequently disposed at the facility. The solid waste volume will consist primarily of two waste forms: potentially contaminated soil and building debris. These solid waste forms will be the products of contaminated soil excavation and building demolition and are assumed to be placed in the proposed on-site land disposal facility for purposes of this study.

The volume estimates of all contaminated sites were the most current information available for the quantity of potentially contaminated soils and buildings. The estimate of potentially contaminated materials is referred to as the expected waste volume estimate, in bank

cubic yards (bcy), a bcy is one cubic yard of material as it rests in a site. Expansion and compaction factors will be applied to the expected-volume estimate. These factors will be used to estimate the volume of contaminated materials hauled to the disposal site as well as to estimate the compacted volume of waste in the land disposal facility. Both expansion and compaction factors will be developed for the various waste types and forms.

Chemical and physical properties of RMA waste were also basic items in waste characterization. Since RMA wastes displayed diverse properties, selected RMA wastes will be described to reflect the range of chemical and physical properties important to the planning of the land disposal facility.

Waste locations are another important consideration for the location of the land disposal facility. The closer the facility is to the centroid of major contaminated material volumes, the lower the cost in waste hauling or transportation. The waste centroid was determined based on a volume times distance calculation, which will be done for the RMA waste sites with over 20,000 bcy. The chosen RMA waste sites, waste volumes, and waste centroid are presented on Figure I-1.

I.3 REVIEW OF PAST WASTE CHARACTERIZATION STUDIES

The documents described in Appendix A - Bibliography were reviewed. The DALF and the current Remedial Investigation/Feasibility Studies (RI/FS) of Ebasco Services Incorporated (Ebasco) and Environmental Science and Engineering, Incorporated, (ESE) for the U.S. Army Program Manager's Office for Rocky Mountain Arsenal Contamination Cleanup (PMO) were the best sources of waste characterization information. These documents are briefly summarized in the following sections.

 $\begin{tabular}{ll} \textbf{TABLE I-1} \\ \textbf{SUPPMARY OF CONTAMINATED MATERIAL VOLUMES IN } DALF^{1/2} \\ \end{tabular}$

	Vas	te Form			W	aste Type	
Section Number	Excavation Volume (bcy)2/	Buildin and Equipme Volume	ent l	Volume of Toxic and Hazardous (bcy)	UXO	Surety Volume (bcy)	Total Section Volume (bcy) 2/
24	96,000		9(5,000			96,000
19	1,000			992	8		1,000
20	1,000			992	8		1,000
26	4,322,000		4,32	2,000			4,322,000
25	18,000	29,300	18	B,000		29,300	47,000
30	407,000		31	7,388	1,612	88,000	407,000
29	254,000		25	2,306	1,694		254,000
35	118,000		11	7,535	465		118,000
36	5,526,000		81	2,826	2,777	4,710,397	5,526,000
31	169,000					169,000	169,000
32	148,000		14	7,808	192		148,000
4	374,000		37	4,000			374,000
3	32,000	*****	3	2,000			32,000
2	1,733,000	12,310	1,60	2,291	9	143,010	1,745,000
1	2,203,000	23,400	2,02	5,200		201,200	2,226,000
6	97,000				-	97,000	97,000
5	147,000					147,000	147,000
11	53,000		5:	3,000			53,000
12	119,000		119	9,000			119,000
TOTAL S	15.818.000	65.010	10.29	L.338	6.765	5.584.907	15.883.000

^{1/} DALF, 1984.

^{2/} Volume rounded to nearest thousand bank cubic yards.

I.3.1 Decontamination Assessment of Land and Facilities at RMA, 1984

The "Decontamination Assessment of Land and Facilities at RMA" (DALF) study
presented the evaluations and findings of the RMA Contamination Control

Program Management Team (RMACCPMT 1984/RIC 84034R01, hereafter cited as DALF,
1984). The report documented the results of several years of study to assess
the feasibility and cost of decontaminating all or portions of RMA.

The methodology used for the study involved: 1) review of applicable Federal and state requirements affecting decontamination of government real property; 2) review of existing data to define areas, types, and volumes of contaminated materials at RMA; 3) development of technical approaches to decontaminate RMA property; and 4) estimation of costs that would be incurred to allow both partial and total unrestricted use of RMA. The DALF evaluated procedures that could be used to handle, process, and dispose of unexploded ordnance, contaminated buildings and equipment, toxic and hazardous materials, and surety agents.

Soil removal volumes were calculated by multiplying the estimated areal extent of the contaminated sites by a depth estimate based on historic activities conducted at the sites and on the available geologic information. The estimated areal extent of contamination and volume estimate for each site is shown in Attachment A, Table A-1. A summary of volume estimates by land section is presented in Table I-1. The DALF study estimates a total of about 16 million bey of contaminated soil, buildings, and equipment from the 88 potentially contaminated RMA sites.

In addition to the contaminated wastes, about 2.31 million square feet of uncontaminated buildings and structures were identified that would also be demolished for disposal but were not included in the 16 million bey estimate.

I.3.2 Results of Ebasco Services Incorporated's Remedial Investigation and Feasibility Study Tasks at RMA
The Ebasco RI/FS results of Tasks 2, 7, 10, 11, 12, 15, 17, 24, and 34 provided data on potentially contaminated materials, primarily contaminated soils and buildings at more than 60 sites and 1,200 structure locations. The

Ebasco studies described the volume of potentially contaminated materials using indicator levels of target analyte concentrations. Indicator levels are the lowest levels that can be detected, or in the case of metals, the background levels. These potentially contaminated materials volume estimates are subject to revision upon establishment of action levels of target analytes, which will permit eventual identification of the actual inventory of waste requiring remediation at EMA.

A detailed presentation of estimates of potentially contaminated material drawn from the more than 45 Ebasco contamination assessment reports (CARs), cross-referenced to RMA task numbers, is presented in Attachment A, Table A-2. The sources used to make Table A-2 are also listed in Attachment A. These potentially contaminated material volume estimates are based on review of historical information, soil borings, site geology, hydrology, soil contaminant levels, and building decontamination assessments. This site information was summarized by RMA section and site for contaminated soil and by RMA section for the buildings.

I.3.3 Results of Environmental Science and Engineering, Incorporated's
Remedial Investigations and Feasibility Study Tasks at RMA

The ESE RI/FS task results that were useful for waste volume estimates for the contaminated sites at RMA were Tasks 1, 6, 14, and 21. These tasks encompassed more than 45 CARs, with particular emphasis on major potentially contaminated sites in Sections 26 and 36. ESE volume estimating procedures were similar to those described for the Ebasco RI/FS studies. A summary of expected volumes of potentially contaminated materials is presented in Attachment A, Table A-2. The ESE CARs were the source of many of the potentially contaminated material estimates listed in Appendix A - Bibliography. The ESE CARs found potentially hazardous and toxic materials to be the primary waste at RMA sites investigated; however, some potentially agent-contaminated materials and UXOs (i.e., bursters) were also identified.

I.3.4 Current Waste Volume Estimates

The DALF, Ebasco, and ESE studies have provided estimates of potentially contaminated materials as shown in Attachment A, Table A-2. This estimate

represents the bank volume of waste; however, the excavation of soil and demolition of buildings creates an expanded-volume or loose condition that requires a loose cubic yard (lcy) estimate. Much of the near-surface geology of RMA is Pleistocene alluvium (May, 1982/RIC 82295RO1). Surface soil material can consist of sand, silty sand, or silty clayey sand (USDA 1974). The expanded volume can be between 1.1 to 1.2 times the bank volume for sand or sand and clay (Caterpillar, 1981 p. 500). A 1.15 expansion factor is, therefore, used for conversion of the contaminated bank volume estimates to loose volume estimates for purposes of establishing waste hauling requirements.

The compacted volume factor for contaminated soils, placed in a land disposal facility waste cell, could range from 1.0 to 0.85 compared to the bank volume estimates (Caterpillar, 1981 p. 500). A 0.95 compaction factor was selected as a reasonable estimate for purposes of estimating compacted contaminated soil volumes as they would reside in the disposal facility. These volume estimates were used for sizing the land disposal facility.

The exceptions to the above expansion and compaction factor estimates are as follows:

Basin F, Site 26-6, is an identified source of heavily contaminated waste, some of which appears to be hazardous waste, and all of which will likely be treated prior to disposal (Ebasco, 1985; Ebasco, 1986a). Heavy contaminated waste for purposes of this estimate are wastes that contain target analytes to 9 levels of 3 or more orders of magnitude greater than the indicator levels given in Attachment B. While the treatment processes have not been selected for Basin F materials, the treatment processes could expand the expected volume of disposed waste by a factor of 2.0 if chemical stabilization/fixation is selected (Conner, 1986; Meyers, 1985; Landreth, 1982). This factor is conservatively applied to the bank volume of Basin F materials to obtain the compacted volume estimate in the disposal facility and reflects the potential for further discovery of heavily contaminated materials that will require treatment.

o Building debris can expand from its bank volume by as much as 1.5 (Ebasco, 1987). The recompacted volume of demolition waste is variable and is less than the expanded volume by as much as a factor of 0.8 (Tchobanoglous, 1977), or 1.2 times the original volume.

It is assumed that unexploded ordnance would be demilitarized with little or no hazardous waste generated in the process (DALF, 1984). Volume estimates for UXO will therefore be treated as contaminated soil.

Surety-contaminated material may be subjected to thermal treatment so as to comply with DARCOM Regulation No. 385-102, p. 5-1 (DALF, 1984). This treated material will subsequently be handled similarly to contaminated soil.

The summary of the estimated (bcy), expanded (lcy), and disposal (ccy) volumes calculations for each site is shown in Attachment A, Table A-2. Waste volumes by RMA section are presented in Table I-2, which presents the current estimates for the expected bank volumes and applies the factors described above to obtain the expanded and disposed volumes. Table I-2 is used as the conceptual basis for the design capacity of the land disposal facility.

To put the estimated volume of material in perspective, the 16.5 million 1 cy of material is equal to approximately 110,000 standard 150 cy railroad coal-carrying cars or 660,000 25 cy trucks. If all of the potentially contaminated material were moved off-site at the rate of one 100 car train or 100 trucks per weekday, it would take approximately 4.4 years by rail and 26.6 years by truck to move all of this material.

Three factors could change the current estimates as represented in Table I-2. They are the RMA groundwater cleanup strategy, land use plan, and final results of remedial investigations and feasibility studies. These factors can increase or decrease the potentially contaminated soil volumes to be disposed.

RMA	Estimated Volume	Expanded Volume	Disposal Volume
Section	(bcy) ^{2/}	(1cy) ^{2/}	(ссу) ^{2/}
1	2,180,800	2,518,900	2,079,900
	1,716,000	1,978,100	1,633,500
2 3 4	47,800	55,000	45,500
4	444,000	510,700	421,900
	147,000	169,100	139,700
5 6	97,000	111,600	92,200
7	400 to 400 to 400		
8			
9			
11	53,000	61,000	50,400
12	244,000	280,600	231,800
19	1,000	1,200	1,000
20	1,000	1,200	1,000
22			
23			
24	96,000	110,400	91,200
25	47,300	64,700	52,300
26	3,250,000	4,259,000	3,732,300
27			
28	diges signs sittes		
29	34,200	39,400	32,500
30	163,600	188,200	155,500
31	169,000	194,500	160,700
32	140,000	161,100	133,100
33			
34			
35	122,000	140,400	116,000
36	3,630,900	4.178.200	3,451,600
TOTAL3/	12,586,600	15,023,800	12,622,100

^{1/} Rounded to nearest 100 cubic yards.

^{2/} bcy: bank cubic yards; lcy: loose cubic yards; ccy: compacted cubic yards

^{3/} The volume estimate is used as the conceptual design basis for Task 27. It represents the best information available as of February 6, 1987 with the exception of Section 26 where an April 1987, volume estimate is incorporated.

RMA cleanup alternatives may include emphasis on groundwater pumping and treatment, capping, in situ treatment, or selected incineration of contaminated materials prior to disposal. The groundwater cleanup strategy may result in the exclusion of certain sites from excavation based on low soil contaminant concentrations leading to a determination that a no-action alternative or an alternative technology, such as capping, most effectively limits the risk to public health and safety.

The second factor that could modify soil excavation estimates is the land use plan, which will affect what action levels are developed from the Preliminary Pollutant Limit Values (PPLVs) and applied to decisionmaking in excavating contaminated soils. PPLV is a contaminant concentration level, where risk assessment modeling suggests concerns for health risks due to the exposure of the public to a particular contaminant. PPLVs will vary depending on land use decisions reflecting the ultimate disposition of the Arsenal area. Soil concentration PPLVs lower than indicator levels for target analytes could translate into action levels that increase the site cleanup excavation volume estimates by a significant amount. The converse of this situation is the choice of PPLVs above target analyte indicator levels, which could mean action levels, that reduce excavation volumes of potentially contaminated material from the current estimates.

The third modifying factor is that results of the remedial investigations and feasibility studies at many sites are not completed. Upon completion of these studies, contaminated soil volumes estimates may significantly decrease or increase as noted in Attachment A - Table A-2.

I.4 WASTE TYPES

The potentially contaminated materials at RMA were classified into three waste types: hazardous and toxic materials, unexploded ordnance, and surety-contaminated materials. These waste types applied to the nature of the contamination of the two major waste forms, contaminated soils and building debris. More than 60 chemicals, from a list of over 666 chemicals used at RMA or degraded products of these chemicals, were considered target analytes for

analysis of potentially contaminated soils and building debris (G&M, 1986; Ebasco, 1986). Attachment B presents a list of target analytes, indicator levels, and waste types.

I.4.1 Hazardous and Toxic Materials

The Ebasco studies described the volume of potentially contaminated materials using indicator levels of target analyte concentrations. Indicator levels were the lowest levels that could be detected, or in the case of metals, the background levels. These potentially contaminated materials volume estimates are subject to revision upon establishment of action levels of target analytes, which will permit eventual identification of the actual inventory of waste requiring remediation at RMA.

While the DALF estimated 10.3 million boy of hazardous and toxic contaminated soils and building debris, the current studies as of February 6, 1987, lead to an estimate of 13.3 million boy, representing almost all of the RMA waste (Table I-2).

I.4.2 Unexploded Ordnance

Of the more than 88 sites identified in the DALF as containing hazardous and toxic materials, 18 were identified as also containing, or possibly containing, unexploded ordnance (UXO). The two basic types of ordnance that might be found at RMA include high explosive (HE) and surety materials. The total volume estimate is almost 7,000 cubic yards of UXO waste, based on the assumption that test sites, mortar ranges, bomb drop areas, and demolition grounds contained 0.1 percent by volume of UXOs. All surety UXOs were expected to be found within Section 36, and the remaining UXOs were assumed to be of the high-explosive (HE) type. All the above estimates are from the DALF.

The current RI/FS studies by Ebasco and ESE (see Attachment A - Bibliography) identified a potential 450 bcy of UXO wastes at potentially contaminated Site 30-1 (ESE 1986b). Since the UXO waste would be demilitarized before disposal, this waste type will be incorporated into the contaminated soil volume estimate for the design of the land disposal facility.

I.4.3 Potentially Agent Contaminated Materials

Potentially agent-contaminated material (PACM) is soils or other solid wastes that, through post exposure to chemical warfare agents, contain detectable levels of agents or their byproducts. These agents attack the blood, the nervous system, or the skin to cause injury or death in their active or concentrated states (G&M, 1986). These materials can potentially degrade into chemical contaminants in the soil, as shown in Appendix B. Examples of these materials are mustard gas and Sarin. The toxic character of surety materials and some of their degradation products may cause them to require special thermal treatment.

The DALF study estimated 5.6 million bey of potentially agent—
contaminated materials at RMA. The Phase I CARs have identified significantly
less PACM. Site 36-17, a complex disposal activity site, identified mustard
contaminated soils that will require Phase II investigation before a
determination of surety materials quantities can be made. It is assumed that
PACMs will be treated if detectable level of chemical warfare agents are
discovered before the PACMs are disposed at the hazardous waste landfill. The
volume of PACMs is incorporated into the contaminated soil volume/estimate.

I.5 WASTE FORMS

Waste form denotes the structure of the waste. The two basic waste forms are building debris and excavated soils. Of these waste forms, the excavated soil volume is by far the larger. Of particular importance is the division of soils into lightly contaminated and heavily contaminated soil categories. These categories of contaminated soil indicate the need for flexible designs, with regard to the volume of waste and the relative volume of each type of waste that may be handled and disposed of at a land disposal facility.

I.5.1 Building Debris

More than 1,200 structures on RMA, including 566 buildings, 132 tanks, and 220 transformers, were assessed for their potential contamination under Task 24. It is assumed for Task 27, as a worse-case, that essentially all contaminated buildings will be removed and disposed in an on-site land disposal facility.

Uncontaminated buildings would be disposed in another on-site appropriate areas. The placement of this contaminated debris would be in the center portion of the waste cells of the land disposal facility to minimize the mechanical hazard to barriers due to handling or settling.

The buildings' volume includes any associated equipment, tanks, piping, and utilities. The equipment items, like many of the structural items, are bulky and will require handling equipment that differs from that used for contaminated soil.

Material from building demolition will generally consist of concrete and masonry rubble, wood, steel sheets, and miscellaneous steel. The size of the material to be disposed will range from fist-sized chunks of concrete to substantially larger pieces that will require lifting equipment such as front-end loaders. Steel sheets of various sizes will be obtained from roofs, walls, or tanks. Wood and steel debris will vary in length and will be reduced to sizes cost effective for transport and disposal.

The preliminary demolition estimate of contaminated buildings and structures is about 65,000 bcy (DALF, 1984). An expansion factor of 1.5 will be applied to the bank volume estimate of building debris to obtain a loose volume of about 98,000 lcy. The compacted volume of building debris is estimated at 0.8 times the loose volume estimate, based on concrete and brick being a primary demolition waste (Tchobanoglous, 1977).

In addition to the standard building debris, there will be liquid or gaseous hazardous materials, PCB-contaminated equipment, and asbestos in the more than 650 buildings at RMA (Ebasco, 1987; Lund, 1982). The liquid wastes will be treated. The solid waste will be handled in a small special waste handling area for asbestos, rinsed transformer cases, and empty fuel tanks or compressed gas cylinders. Based on detailed decommissioning work by Ebasco (1987), 1 percent of the demolition waste may be such special waste, or about 6,000 lcy based on current estimates of contaminated and uncontaminated building demolition volumes.

The description of this demolition waste is expected to change with more detailed assessment of building contamination in RMA Task 24. If these future studies find additional contaminated materials, the new volume would be added to the design capacity of the land disposal facility.

I.5.2 Excavated Soil

Heavily contaminated soil is defined, for the purposes of this task, as soil materials having some target analyte concentrations three or more orders of magnitude greater than detection limits. The soil underlying the Basin F liner is heavily contaminated at certain boring locations (ESE, 1987c). The ESE estimate of 614,000 bey reflects the most recent information regarding these heavily contaminated materials exclusive of findings reported after 2/6/87. Other heavily contaminated areas are anticipated in Basin A and South Plants as the Phase II CAR investigation are completed. Table I-3 presents a summary of analyses of these heavily contaminated soils.

The Basin F liquid, liner overburden, and liner are the only heavily contaminated materials at RMA that are presently identified as suspected hazardous wastes (Myers & Thompson, 1982/RIC 82350R01). These hazardous wastes are defined as wastes that will not pass the tests of 40 CFR 261.20 characteristics of hazardous wastes.

Ongoing studies under other tasks will refine the quantity of heavily contaminated materials from Site 26-6 and other RMA sites that belong in this category and may require treatment before disposal in the hazardous waste landfill. The treatment of Basin F materials is beyond the scope of Task 27; however, it is assumed for the purposes of this task that Basin F material will receive treatment before its final disposal to reduce the concentration or mobility of more than 20 target analytes, such as the volatile and semivolatile organic chemicals and the metals. Such treatment will help ensure that the land disposal facility barriers are compatible with the treated wastes. This will be discussed in more detail below and in Section 6. The expansion and compaction factor will be 2.0 (twice the bank volume estimate) to reflect the fixation or solidification of Basin F materials and allow for possible discovery of other heavily contaminated site areas during Phase II CAR investigations.

TABLE 1-3 CONCENTRATIONS OF CONTANINANTS IN SOIL SAMPLES UNDENLYING BASIN P LINER

Tedans.				Concent	concentrationa (ug/g)	104 (119/01)	Ė	Reference meteration	Pat and I m	
Constituents Detections*		Range	Hean	Median		Standard Deviation	Limit (ug/g)	Limit (ug/g)		
Volatiles (M-40)										
Chlorobensene	~		0.8-5		~	m		••	6.0	F . G
CHC11	· m		0.3-70	2	2	•	•	9	m 6	2.0
1,2-Dichloroethane	-			•		· ¦	•	: :		•
BCRD	· •		2-30	_	•	arī				
BCHD	-		25		· :	· :	•		; ;	}
Bthylbensene	~		1-8		•	•		•	6.3	•
Tetrachloroethene	^		1-40	_	2	9	-	10	0,3	5.0
Tetrachloroethene	-		25		;	:		,		1
Toluene	^		1-1000	_	400	300	7	99	0,3	6.3
Toluene	ł		25		:	1	•		;	1
1,1,1-Trichloroethane	-		7.0		;	;	•	•	0.3	6.5
B, Kylene	~		0.4-5		7	~		~	0.3	1
HIBK	~		- 1 -	_	0.1	7.0		7.0	0.5	
DHDS	•		2-60		30	2	•	e	0.3	9.
Denzene	m		1-3		~	~		-	0.3	•:
o,p-xylene	7		2		;	1	•		5.0	S.0
Semi-Volatiles (N-40)	·									
Aldrin	•		0.7-4000	000	1000	1000	100	•	6.0	6.5
Dieldrin	1		100-2000	000	200	4 00	200	•	6.3	9.0
Endrin	1		906-D6	90	200	007	300	•	0.7	••
9110	7		0.5-0.8	•	9.0	0.7		0.7	o.s	9.0
Isodria	~ 1		100-3000	8 9	000	1000	1900	•		
acad				0.444.8.3	7 6			5		96
2000	~ ~		, C. 700	7	707		, 64			
PCPHSO	, an		4-70	2 _	207	•	,	30	7	7:0
Dente	•		3-70	_	2	~		•	~	0.0
PCPH802	1		0.5-300	9	30	50		70	0.3	7.0
Hetals (W-40)										
Cadatus	-		2.0		1	1	•	ļ.	6.0	6.9
Chronium	36		11-34	=	=	=		5.6	7.2	7.
Copper	2		5.0-2300	200	S	2	E	370	•. • ;	•
Feed	₹ ;		18-35	<u>د</u>	24	7		7.7	.	= :
	S (33-320	950	5	57		•	<u>.</u>	, R
Areelo	07		4.6-16		• •	7.6				
	-		0.0-80.0		90.0			B0.0	79.5	

^{*} Number of samples in which constituent was detected. W = Number of samples analyzed. Source: ESE, 1986c.

Lightly contaminated soils are defined, for the purposes of this task, as potentially contaminated materials with target analyte concentrations within two orders of magnitude of the indicator levels. These wastes are also suspected hazardous wastes. They contain lower levels of hazardous and toxic chemicals than the heavily contaminated soils, and except for a few cases, where chemicals on the EPA Prohibited Substance List are found, they would likely pass the extraction procedure tests (CRF 261.24). Table I-4 provides an example of contaminants and their concentrations detected in 34 samples from this category of lightly contaminated soils, in this case from the South Plants area.

As of February 6, 1987, the volume estimate of contaminated soil is about 12.6 million bey, 15.0 million ley and 12.6 million cey for land disposal facility design purposes. This estimate represents all wastes, including Basin F contaminated materials and other heavily contaminated or agent-contaminated material, that are expected to be treated before disposal in the hazardous waste landfill.

I.6 CHEMICAL PROPERTIES OF WASTES

This section will discuss measured target analyte levels, waste-to-waste compatibility, and waste-to-barrier interactions. These properties are of importance to waste control so that incompatible wastes can be segregated into different waste cells for disposal. This section will provide a general discussion for concept design purposes because chemical properties may not be completely defined for all potentially contaminated sites. This review will identify potential problem areas for waste placement.

I.6.1 Measured Levels of Target Analytes

A summary of measured contaminants at RMA is presented in Table I-5, which was compiled from the USATHAMA database of soil boring data. The "hits" are contaminant levels greater than the specific analyte detection levels or indicator levels. The average for hit levels is shown for 49 analytes in Table I-5. Each average represents an estimate of concentration levels of that analyte in soils potentially contaminated with that analyte. The average analyte levels range from 0.1 to 200 ppm. While the information is not weighted for soil quantity as well as chemical concentration, it is useful for

TABLE 1-4

ANALYSIS OF DATA ON CHEMICAL CONSTITUENTS DETECTED DURING PHASE I PIELD STUDY OF BURIED SLUDGE*

Constituent of Detected Sar Level	Number Of Samplea <u>l</u> /	Range M	Standard Range Median ² /		Detection Nean <u>2</u> /	UBTL Detection Deviation2/	CAL Indicator Limit	Limit
Volatiles (N=3)3/								
None detected								
Gestvoletiles (7834)	•	A_3	•	1	•	0.3	0.3	5
Aldrin	n •	07-1-0	•	- 1	• 1		9,0	2
Chlordene	٦,) F	•	~	0.3	ă
Dieldrin	•	07-6-0	•	•	•	? •		Ž
Endr in		~	1		•	C 9	•	3 ;
Hexachlorocyclopen	tadiene 1		1	•	•	9.0	F.0	3
Dibromochloropropane (N#34)	(N=34) 1	0.018	1	ı	1	0.0050	0.014	7
ICP Metals (N-34)						;	;	•
Cadatus	-	1.1				0.74	99.0	1.0-2.
	S	6.6-16	60,60	9.7	2.4	6.5	5.2	25-40
	24	5.6-32	7.5	9	₹.9	4.7	4.9	20-35
	-	14-26		•	•	4.8	13	25-40
	. 2	12-57	2.7	28	9.6	8.7	9.5	08-09
176-07	; -	9.0	; ¹	·		2.5	5.0	DL-10
Mercury (N=34)	11	0.056-2.3	3 0.43	0.70	0.73	0.050	090.0	DL-0-10

DL - The indicator level is the detection limit for UBTL and CAL Laboratories, as appropriate N - Number of samples analyzed $\frac{1}{2}/-\text{Number of samples in which constituent was detected} \\ \frac{1}{2}/-\text{Median, mean, and standard deviation not calculated when constituent detected in fewer than five samples <math display="block">\frac{2}{3}/-\text{Volatiles were analyzed only in three samples of Boring 6}$

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the concept design basis, as it serves as a guide to the concentrations of chemicals that disposal facility barriers must withstand.

The contaminated soils at EMA generally have low target analyte levels, except for the relatively small quantities of heavily contaminated or agent-contaminated materials (Ebasco, 1985; ESE, 1987c). Analyte levels as high as 4,000 parts per million (ppm) of aldrin and dicyclopentadiene, 3,000 ppm of isodrin, 2,300 ppm of copper, 2,000 ppm of dieldrin, 1,000 ppm of toluene, and 900 ppm of endrin are found in soils underlying the Basin F liner (ESE, 1987c). Those materials may require treatment before land disposal if they are found to be banned wastes and if variance approval is not likely due to questions of analyte toxicity and persistence. While Task 27 will not determine the treatment for Basin F materials and heavily contaminated soils, the hazardous waste land disposal facility design assumes they will be treated to a condition acceptable for land disposal. Therefore, all RMA potentially contaminated materials are assumed to be wastes that have not been banned for land disposal, whether by treatment processes applied to heavily contaminated materials or low target analyte levels in the lightly contaminated materials.

I.6.2 Waste-to-Waste Compatibility

An important consideration in disposing of RMA wastes is the chemical compatibilities of the potentially contaminated materials. Some of these wastes may have chemical incompatibilities that will require segregation in the land disposal facility; chemical compatibility assessment is a determination of which wastes can be disposed of together. This assessment is required to avoid the commingling of wastes that may create uncontrolled problems of fire, explosion, toxic gas generation, and heat production.

More than 60 selected hazardous materials and chemicals of concern due to toxicity, persistence, or migration are known to be present in RMA soils and are presented in Table I-6 by name and chemical reactivity group, chemical surety agents, and suspected and known carcinogens are identified (G&M, 1984; Hatayama, 1980). Actual waste chemical composition will vary with excavation or treatment technology, and with soil PPLVs that may be used as criteria for the cleanup of RMA.

TABLE 1-5

HEASURED CONTAMINANTS AT RHA 2/

	Chemical Hits Sam	Samples	(Percent)	(Percent)	Averagete by
LDRW	ALDRIN	2	2,559	3.7	1045520
15	ARSENIC	524	~	20.1	14812327
it:	ATRAINE	1		0.3	9.810.6
CHPD	BICYCLOHEPTADIENE	E1		1.2	3.615.4
10.	CARBON TETRACHLORIDE	7	970	0.2	0.3
e	CADMIUM	169	2,520	6.7	13.25146
:HCL3	CHLOROFORM	16	970	1.7	2.952.6
H2CL2	METHYLENE CHLORIDE	82	827	9.9	4.2110.5
CLC6H5	CHLOROBENEENE	5 0	97.1	0.5	2.412.0
LDAM	CHLORDANE	22	2,555	0.9	26.2520.2
17 6 CP	REXACHLOROCYCLOPENTADIENE	=======================================	2,568	0.4	15.5128.9
PHS	P-CHLOROPHENTLASTHYL SULFIDE	11	2,563	1.0	1211230
PHSO	P-CHLOROPHENTLASTHYL SULPOXIDE	11	2,563	0.7	7.5116
14. CPMS02	P-CHLOROPHENTLARTHYL SULPONE	42	2,573	1.6	17.0149
ĸ	CHROMIUM	1,661	2,521 6	62.9	13.716.7
P.	COP PER	2, 145		85.1	16.0153.6
26H 6		21	1,053	2.0	5.416.7
CPD	DICYCLOPENTADIENE - Semivolatile	19	2,447	•	119.851456.0
DOVP	VAPORA		2,576	0.00	3.0
SIMP	DIISOPROPILMETHYL PHOSPHONATE	34	2,563	1.3	3.212.6
DITH	DITHIAME	.	2,545	0.2	3.754.5
DLDRM	DIELDRIM	223	2,557	8.7	23.31146.4
DATOS	DIMETHYLDISULPIDE		1,039	0.2	4.355.0
SHORK	BWDRIN	31	2,567	1.2	55.51165
ETC685	ethyleresere	11	1,044	1.0	2.112.9
10	MENCURY	369		14.2	0.310.7
TROOM	ISODRIN	45		1.0	86.21447
TEC 6HS	TOLUENE	12	1,039	1.3	1.752.2
HIBK	METHYL I SOBUTYLKETONE	12	696	1.24	2.313.6
## ST		•			

TABLE 1-5 (Continued)

HEASURED CONTAMINANTS AT RHA

		Chemica 1	Number of Hits	ĕ	Number of Samples	Frequency (Percent)	Hits concentrations (ppm) Averagele
31. 08	74	1.4-OXATHIANE	-		2,549	0.0	9.9
32. 98	<u>.</u>	LEAD	168		2,518	30.5	28.3552.3
3	200	DICHLORODI PHENTLETHANE	23		2,573	6.0	3.634.6
		SACRETACED. THE TATAL THE LANGE THE SACRET			2,564	0.7	7.117.0
		BALAFUTCH	7		2,539	0.0	6.0
		2-car obo-112 4-Biter oboses.	7		2,570	0.15	5.819.5
		VINYLDIETHYL PROSPHATE	•				
37. 10		TETRACHLOROSTHANS	20		196	2.1	3.516.2
		TRICKLOROSTHLEMS	_		196	0.1	0.3
	120CR	TRANS-1.2-DICHLOROETHENE	-		286	0.2	0.3
707	15.84	ORTHO- AND PARA-XYLENE	12		1,047	1.1	6.110.0
		TIEC	2,374		2,519	94.2	47532
42.	Incr.	1.1-D1 CHLORORTHANK			1,048	0.0	6.0
	1 TCA	1.1.1-TRICHLOROSTHANS	· ••		97.1	0.5	1.251.2
7	2000	1.1.2-FRICKLOROETHANE	_		1,049	0.0	0.3
	2017E	1.2-DICHLOROFTHAME	•		1,048	0.4	110.7
46.	Power		15		1,046	1.4	1.912.5
		DIMETHYL METHYL PHOSPHATE	•		1,086	9.0	10.7£26
7		1.2 DICHLOROETHENE	•	_	294	1.02	6.6[3.3
\$	ACP.	DIBROPOCHLOROPROPANE	61	_	2,310	7.6	.145.44
	!						

The data presented is from a data base query conducted on 7/17/86 from RMA Task 35. e is the standard deviation.

Given the diversity of waste types and contamination levels, an assessment of hazardous materials compatibilities is important in the design of the land disposal facility. A compatibility chart for chemical reactivity groups is shown in Table I-7 (Hatayama, 1980). This chart shows that surong oxidizing and reducing agents are incompatible with all other chemical reactivity groups common to RMA wastes, suggesting the necessity of segregation or treatments of certain wastes before disposal. An example is treatments of hydrazine compounds, which are presently receiving separate attention as part of the hydrazine blending and storage facility decommissioning efforts under Task 34 (Ebasco 1987). Another important chemical reactivity group is explosives. Explosive materials will be handled separately from other waste to ensure demilitarization of unexploded ordnance. In addition, potentially agent-contaminated materials will likely require treatment to be landfilled (DALF, 1984). Another aspect of waste-to-waste incompatibility is the biodegradation product methane, common to putrescible organic materials such as paper or wood. While only minor quantities of putrescible organic materials are expected, the design will provide for gas venting.

Many RMA contaminated materials have chemical constituents that fall into eight chemical reactivity groups: 9, 16, 17, 19, 20, 24, 27, and 32. These reactivity groups appear compatible with one another so that disposal of these contaminated materials in the same waste cell is acceptable.

Many of the contaminated materials at RMA are lightly contaminated soils with low concentrations of various chemicals. Reactivity is often low at dilute concentrations of reagents, since the chemical reagents are dispersed and immobilized in the soil matrix by adsorption or absorption. Waste-to-waste incompatibility should not be a particular problem of these lightly contaminated soils.

I.6.3 Waste-to-Barrier Interactions

The compatibility of the waste cell barrier with the specific wastes is a major consideration in planning and designing a land disposal facility. The design of a lined waste cell must take into account which available liner (barrier) materials will not be degraded by the wastes. Since liquids will

TABLE I-6

SELECTED HAZARDOUS MATERIALS AND CHEMICAL CONSTITUENTS OF ROCKY MOUNTAIN ARSENAL WASTES

Name	Reactivity Grou Numbers
ORGANIC CHEMICALS:	
ALIPHATIC AND AROMATIC AMINES	7
*N-Nitrosodimethylamine (DMNA)	7, 27
Atrazine	7
AZO COMPOUNDS, DIAZO COMPOUNDS AND HYDRAZINE	8
Benzothiazole	8, 102
Monomethyl hydrazine	8
Hydrazine	8
Unsymmetrical Dimethyl hydrazine (UDMH)	8
AROMATIC HYDROCARBONS	16
*Benzene	16
Bicycloheptadiene	16
Ethylbenzene	16
Toluene	16
Xylene	16
HALOGENATED ORGANICS	17
**Aldrin	17
**Carbon Tetrachloride	17
Chlordane	17
Chlorobenzene	17
**Chloroform	17
P-Chlorophenylmethylsulfide (CPMS)	17
P-Chlorophenylmethylsulfone (CPMSO ₂)	17
P-Chlorophenylmethylsulfoxide (CPMSO)	17
DDE (P,P' Dichlorodiphenyldichloroethlyene)	17
**DDT (Dichlorodiphenyltrichloroethane)	17
1,1 Dichloroethane	17
1,2 Dichloroethane	17
1,1 Dichloroethylene	17
1,2 Dichloroethylene	17
Dicyclopentadiene	17
Dieldrin	17
Endrin	17
Hexachlorocyclopentadiene (HCCPD)	17
Isodrin	17
Methylene Chloride	17

TABLE I-6 (Continued)

SELECTED HAZARDOUS MATERIALS AND CHEMICAL CONSTITUENTS OF ROCKY MOUNTAIN ARSENAL WASTES

Name	Reactivity Group Numbers
ORGANIC CHEMICALS:	
HALOGENATED ORGANICS (Continued)	
**Polychlorinated Biphenyl (PCB)	17
Tetrachloroethylene	17
1,1,1 Trichloroethane	17
1,1,2 Trichloroethane	17
**Trichloroethylene	17
KETONES	19
Methyl Isobutyl Ketone (MIBK)	19
MERCAPTANS AND OTHER SULFIDES	20
Dimethyl Disulfide	20
NITRO COMPOUNDS, ORGANIC	27
ALIPHATIC AND UNSATURATED HYDROCARBONS	28
ORGANO PHOSPHATES, PHOSPHOTHIOATES AND PHOSPHODITHIOATES	S 32
Azodrin	32
Malathion	32
Parathion	32
Vapona	32
EXPLOSIVES	102
AGENT MATERIALS AND DEGRADATION PRODUCTS	N/A
Diisopropylmethylphosphonate (DIMP)	n/a
Dimethyl methyl phosphonate (DMMP)	n/a
Dithiane (DITH)	N/A
GB (Sarin)	n/a
Isopropyl methyl phosphonate (IMP)	n/a
Lewisite (B-Chlorovinyl dichloroarsine)	n/a
Lewisite Oxide (B-Chlorovinyl-dichloroarsine epoxide)) N/A
*Mustard (B, 8' -Dichlorodiethylsulfide)	N/A
Thiodiglycol	n/a
Thioxane (OXAT)	n/a

N/A Not Available

TABLE I-6 (Continued)

SELECTED HAZARDOUS MATERIALS AND CHEMICAL CONSTITUENTS OF ROCKY MOUNTAIN ARSENAL WASTES

Name	Reactivity Group Numbers
INORGANIC CHEMICALS:	
*Arsenic	24
Bromine	104
*Asbestos	
ALKALI-BARTH METALS	
Calcium Salts	
Magnesium Salts	- Aller - Alle
Potassium Salts	
Sodium Salts	
Phosphorous (White)	105
HEAVY METALS	
**Cadmium	24
*Chromium	24
Copper	24
**Lead	24
Mercury	24
Zinc	24
Anions	
Bromide	
Chloride	
Chlorate	
Fluoride	
Phosphate	
Sulfate	
notes:	
* Carcinogen	

- ** Suspected carcinogen

Number	Маже												
	Aliphatic and Aromatic Amines	•											
	Azo Compounds, Diazo Compounds and Hydrazine	1	•										
	Carbamates	:	υ ≖	•									
	Aromatic Mydrocarbons	;	1		92								
	Ralogenated Organics	= 5	æ 0			12	;						
	Ketones	:	≖ છ		,	-	2						
	Mercaptans and Other Sulfides	:	ΞU		,	_	F 20	l _					
	Metals and Metal Compounds Toxic	တ	ŀ		;		1	74					
	Witro Compounds, Organic Hydrocarbons	1	;						27				
	Organophosphates, Phosphotioates and Phosphodithioates	!	Ð	'		'		1	1	32			
	Explosives	:	E 20		'	1		1		1	102		
	Strong Oxidizing Agents	#, #	= 0	H, F	E &	= ₽5	# #.		= 20	. t	2 0	104	
	Strong Reducing Agents	≖ ≥	± ∪		,	- m	± ± 5	1	2 10	5 5	= e	H, E	105
==05	Heat Generation Fire Innocuous and Monflammable Gas Generation Toxic Gas Generation	0 D D N	Solubilization of Toxic Substances May Be Hazardous but Unknown Flammable Gas Generation Explosion	Asstit Masar Je Ga	Sous b	Toxic out Un ratio	Subel known n	ances					

[·] Prom Hatayama, 1980.

not be placed in the waste cells, the possibility of undesirable chemical reactions will be reduced.

The U.S. EPA guidance documents and hazardous waste regulations (40 CFR 264) prescribe that a hazardous waste land disposal facility, complying with RCRA, shall have a double-barrier system. The double barrier is one flexible membrane liner with one clay liner, or a composite of flexible membrane liner and clay liner (EPA, 1985). Since the flexible membrane liner would be the first barrier to contact the RMA wastes, its compatibility with the waste is of key importance in the concept design.

A review of the extensive literature on flexible membrane liners was done by A.D. Little, Inc. (1985a). Fourteen of the more than 60 target analytes found at RMA were examined in that review for 23 liners. The high-density polyethylene liner appeared to be the most resistant to the RMA chemicals. Further discussion of barrier-to-waste compatibility is presented in Section 6.

Since the waste characterization data identified chemical compounds not tested for by liner manufacturers, final liner selection should be based on actual compatibility testing.

I.7 PHYSICAL PROPERTIES OF WASTES

No liquid wastes will be allowed in the land disposal facility. The characteristics of the soil and building debris wastes are briefly summarized in this section.

I.7.1 Soil

Four major soil associations are found at the RMA. These include the Alluvial Land, Ascalon-Vona-Truckton, Blakeland-Valent-Terry, and Platner-Ulm-Renohill Associations (G&M, 1984). Of these associations, the Ascalon-Vona-Truckton and Platner-Ulm-Renohill are representative of more than 80 percent of the near-surface soils of RMA (Sampson & Baber, 1974; G&M, 1984). The Ascalon-Vona-Truckton Association is nearly level to strongly sloping, well drained to somewhat excessively drained, and loamy and sandy soil formed in

wind-laid deposits on uplands (Sampson & Baber, 1974). The Platner-Ulm-Renohill Association is a nearly level to strongly sloping, well drained loamy soil formed in old alluvium on interbedded shale and sandstone on uplands (Sampson & Baber, 1974).

Since much of the contaminated materials at RMA are surface soils, the estimated physical properties from the Adams County soil survey (Sampson & Baber, 1974) provides reasonable conceptual design parameters for the contaminated soils. These characteristics of RMA soils are discussed at length in Chapters 4 and 7.

The contaminated soil materials include clays, sands, and silts. Soil physical properties of interest include density, moisture content, ease of transportation and stockpiling, and drying characteristics. These are assumed to be typical for the soil types indicated. The excavated contaminated soils will be assumed to be handled and transported by standard heavy equipment with appropriate personnel safety equipment. The fine component of the materials when dry could be subject to wind transport and will require efforts to minimize this effect (Sampson & Baber, 1974). A volume expansion factor of 1.15 and compaction factor of 0.95 as applied to the bank volume estimate will be used based on literature values (Caterpillar, 1981).

I.7.2 Buildings and Debris

The building debris will consist of broken concrete of various sizes, masonry, wood, steel sheets, and miscellaneous steel. The equipment consists of pumps, piping, motors, and other utilities. Much of the material has a high piercing ability and, therefore, must be isolated from any liners in the land disposal facility. The DALF addresses the disposal of this material, either with the relatively large quantity of soil materials or in a separate facility specifically designed for this type of waste. The procedure would be to incorporate the contaminated building debris in the center of the waste cells of the land disposal facility so that it would occupy only a few percent of the volume of any given cell. Materials will be placed in such a manner that voids will be filled between pieces to preclude settlement.

I.8 WASTE LOCATIONS

The closer the disposal site is to the centroid of contaminated materials (waste centroid), the lower the hauling costs and environmental impacts from heavy vehicle operations. Forty sites, each over 20,000 bey and totalling more than 90 percent of the contaminated materials, were used as a basis for the waste centroid determination. The waste centroid was determined to be very close to the Basin A neck area in Section 36, as shown in Figure I-1. Five major contaminated sites are located near the waste centroid. These sites include the South Plants (1-13 and 2-18), Basin A (36-1), Basin C (26-3), and Basin F (26-6). The waste centroid and major sites are also located near the paved roadway system. The location of a disposal site in close proximity to paved roads and the waste centroid reduces the waste transportation costs and environmental impact of the disposal site location as discussed in Chapter 3.

I.9 SUMMARY

The estimated design volume of potentially contaminated material was based on the review of past and ongoing studies is about 13.3 million boy,

16.5 million loy, and 14.1 million coy. A comprehensive comparison of volumes by section is provided in Table I-2 and by individual site in Attachment A.

This total volume includes approximately 65,000 cy of contaminated building debris and approximately 7,000 cy of unexploded ordnance, with the remaining major volume consisting of toxic and hazardous material or chemical surety contaminated soils. The volume estimates were generally based on estimated areal extents of contamination multiplied by estimated depth of excavation required to effectively remove the contaminated material. The estimates were derived from the DALF and Ebasco and ESE Remedial Investigations data. These sources characterize the potentially contaminated materials as all material at or above target analyte indicator levels, which are the detection thresholds or background levels. Expansion and compaction estimates were based on literature values and engineering judgment.

			MAN O NO SEET		WASTE CENTROID EBASCO RMA TASK 27 FRUME I-1
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	2	8	ਲ	u	~
	\$	160	A WISTON	PLANTS	ā.
	S2		CENTROID	2 South	=
	n	MASIN P. S.	WASTE	٠	1
	z	8	SS.	*	6
N. P. grange		·* · · · · · · · · · · · · · · · · · ·	\		

The analysis found two basic waste forms, building debris and excavated soil. These waste forms include the following waste volumes: 65,000 of contaminated buildings debris, and 13.3 million bey excavated soil, of which at least 1.4 million bey is estimated to be heavily contaminated soil, as of February 6, 1987.

The chemical properties of the RMA wastes indicate that most can be disposed of together and chemical contaminant levels may range from 0.1 to 4,000 ppm average level for a given analyte as shown in Tables I-3 and I-4. It appears from preliminary analysis that limited potential exists for fire and explosion from untreated RMA wastes.

The physical properties of most RMA wastes will be those of soils from the Ascalon-Vona-Truckton and Platner-Ulm-Renohill Associations.

The potentially contaminated materials are located at more than 100 sites on the RMA. The waste centroid is near five major potentially contaminated RMA sites and the Basin A neck area. A proposed disposal site nearest to this waste centroid will have the least waste haul costs and environmental impacts from heavy vehicle operations.

APPENDIX I

ATTACHMENT A

TABLES

TABLE A-1
SECTION-BY-SECTION INITIAL MATERIAL WANDLING VOLUME ESTIMATES IN BANK CUBIC YARDS (FROM DALF, RMACCPMI, 1984/RIC 84034R01)

1-14 1-15	Section Number	Site ID No.	Type]/	Area Type <u>l</u> / (Sq Ft)	Depth of Excavation (Ft)	Volume of Excevetion	Volume of Equipment and Buildings Demolition	Total Volume	Volume of Toxic and Hazardous	Volume of UXO29	Volume of Surety	Degree of Confidence
-5	~	1-1	2	115,200	02	43,000		43,000	43,000	:	:	Moderate
-7 F 691,200 3 73,000 -1 1,000 13,000 15,000 1			: ~	} }	: =		:		•	:	:	:
1-8 F 294,400 3 33,000 35,000 33,000 175,000 175		-	C 14.	691,200	<u>.</u> ~	22,000	: :	53,000	53,000	:	:	Moderate
1-10		•	L	294,400	.	33,000	:	33,000	33,000	: :	: :	Moderate
1-13 L 1 3.840,000 10 1778,000		은 : -	 0 •	473,600	2:	175,000	:	175,000	175,000	:	: :	Los
2-1 J 177,600 10 66,000		<u> </u>		120,000	22	44,000	:	44,000	44,000	:	:	5
2-1 J 177,600 10 66,000 66,000 2,226,400 2,025,200 2-2 E 127,600 10 66,000 1,000 18,000 18,000 2-3 A 38,400 15 18,000 1,000 21,000	But	ldings.4/	Æ	198,200	NA NA		23,400	1,778,000 23,400	1,600,200	::	177,800	Lov
2-1	SUBTOTAL			5,828,600		2,203,000	23,400	2,226,400	2,025,200	•	201,200	
2-3	2	2-1	-	177,600	02	99.000	:	66.000	66.000	:	:	4078
2-14 1 198,000 15 21,000 2 21,000 21,000 21,000 21,000 21,000 21,000 22,1000 21,000 22,1000 22		2-5	w	128,000	2	000	:	000		•	1 1	Mr done
2-7 A 25,600 15 14,000 14,000 14,000 21,000 21,000 2-1,000 2-1,000 2-1,000 2-1,000 14,000 14,000 14,000 12-1,000 14,000 12-1,		2-3 2-3	<-	32,000	S	18,000	:	18,000	18,000	٠:	: :	Moderate
2-14 1 196,600 19 73,000 73,000 73,000 2-17 19,14,000 11,176,300 233,000 233,000 2-17 11,700 NA 1,307,000 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,000 1		9.7	< •	38,400	<u>.</u>	21,000	:	21,000	21,000	:	:	Auderate
2-17 H 3,142,000 2 233,000 1,307,000 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,776,		\ <u>-</u> 2	<	198,600	<u> </u>	73,000	:	14,000	14,000	:	:	Moderate
2-18 L 2,822,000 12.5 1,307,000 1,307,000 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,176,300 1,00		2-17	· =	3, 142,000	2 ~	233.000		23,000	73,000	: :	: 1	Moderate
3-2 J 3,480 10 1,000 15		2-18	: ب	2,822,000	12.5	1,307,000	•	1,307,000	1,176,300	:	130, 700	
3-2 J 3,480 10 1,000 1,745,310 1,602,291 3-3 A 27,000 15 15,000 15,000 15,000 3-4 L 28,800 15 16,000 16,000 16,000		erngs:	E	111,700	X		12,310	12,310	:	:	12,310	Hoderate
3-2 J 3,480 10 1,000 1,000 1,000 1,000 35,000 32,000 32,000 32,000 32,000	SUBTOTAL			6,675,700		1,733,000	12,310	1,745,310	1,602,291	-	143,010	
59,280 32,000 0 32,000	•	88 8 8 8 8 8 8 8 8	747	3,480 27,000 28,800	10 15 15	1,000 15,000 16,000	111	1,000 15,000 16,000	1,000 15,000 16,000	:::	:::	Hoderate Noderate Low
	SUBTOTAL			59,280		32,000	0	32,000	32,000	•	•	

TABLE A-1 (Continued)
SECTION-BY-SECTION INITIAL MATERIAL MANDLING VOLGE ENTHATES IN BANK CUBIC YARDS (FROM DALF RMACCPHT, 1984/RIC 84034R01)

Section	Stte ID Mo.	Type 1/	Area Type <u>l</u> /(Sq Ft)	Depth of Excavation (Ft)	Volume of Excavation	Volume of Equipment and Buildings Demolition	Total Yolume	Volume of Toxic and Hazardous	Volume of UXCE	Volume of Surety	Degree of Confidence
•	444 2004	900	154,000 183,000 672,000	000	57,000 68,000 249,000	. 111	57,000 68,000 249,000	57,000 68,000 249,000	: : :	:::	198 198
SUBTOTAL			1,009,000		374,000	•	374,000	374,000	•	•	
8	2-5		1,324,000	9	147,000	•	147,000	•	:	147,000	Lov
SUBTOTAL			1,324,000		147,000	•	147,000	0	•	147,000	
•	6-26/ 6-5 6-6	; _ı_	9,600 867,000	 mm	1.000	:::	1,000	:::	1::	1,000	Low Moderate
SUBTOTAL			876,600		97,000	•	97,000	0	•	97,000	
=	1-1	ပ	339,000	Æ	53,000	:	53,000	53,000	:	:	High
SUBTOTAL			339,000		53,000	•	53,000	53,000	•	•	
15	12-1	υz	356,000 858,000	AN 2	55,000 64,000	::	55,000 64,000	55,000 64,000	::	::	High Roderste
SUBTOTAL			1,214,000		119,000	•	119,000	119,000	•	0	

TABLE A-1 (Continued)
SECTION-BY-SECTION INITIAL MATERIAL HAMDLING VOLUME ESTIMATES IN BANK CUBIC YARDS
(FROM DALF RMACCPMT, 1984/RIC 84034R01)

Section Number	Site ID No.	Area Typel/(Sq Ft)	Area (Sq Ft)	Depth of Excavation (Ft)	Volume of Excavation	Volume of Equipment and Buildings Demolition	Total Volume	Volume of Toxic and Hazardous	Volume of UXO2	Volume of Surety	Degree of Confidence
2	1-61	•	102,000	8	1,000	:	1,000	266	•	:	Moderate
SUBTOTAL			102,000		1,000	-	1,000	366	-	•	
20	20-1	w	102,000	2	1,000	:	1,000	366	•	:	Moderate
SUBTOTAL			102,000		1,000	0	1,000	892	-	0	
22	24-5 <u>6</u> / 24-6	: \$	172,000	: z	000'96	11	000'96	000'96	::	::	ا و:
SUBTOTAL			172,000		000*96	•	96,000	96,000	9	•	Los
દ્ધ	2-52	9	10,800	52	9,000	:	9,000	9,000	ŀ	:	Moderate
	25-3	9 3	21,000	S 4	12,000	 076 F	12,000	12,000	: :	- 626 -	Hoderste
	25-5	: #:	2000	\ E	: :	029	670	: :	:	670	33
	25-6	×	120	¥	:	200	200	:	;	200	3
	25-7	x :	2,800	4 :	:	1,890	1,890	:	;	1,890	<u>\$</u>
•	9-17 20-17	E 3	7,500	E 3	: :	9,000	200	: :	: :	900.0	<u> </u>
	25-10	: 2	61.200	.	:	2.500	7,500	:	:	7.500	5
	25-11	*	8,460	E	:	000.	000	:	:	000	3
	25-12	Z:	000.6	¥	:	1,100	001.	:	:	9	3
	25-13	#	90.	¥	:	200	200	:	:	200	5
	25-14	x :	30,600	K :	:	3,600	3,600	:	:	3,600	3.
	25-15	=	6	4	t t	100	8	:	:	8	Š
SUBTOTAL			315,720		18,000	29,300	47,300	18,000	°	29,300	

TABLE A-1 (Continued)
SECTION-BY-SECTION INITIAL MATERIAL MANDLING VOLUME ESTIMATES IN BANK CUBIC YARDS (FROM DALF RMACCPMT, 1984/RIC 84034R01)

Section Number	Site ID Mo.	Type]/	Area Type <u>l</u> /(Sq Ft)	Depth of Excavation (Ft)	Volume of Excavation	Volume of Equipment and Buildings Demolition	Total Volume	Volume of Toxic and Hazardous	Volume of	Volume of Surety	Degree of Confidence
92	7.5.5.5.5.5.5.5.5.5.5.5.5.5.5.5.5.5.5.5	7 4 4 5 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	3,174,000 877,000 1,280,000 4,051,000	25.25 & D	1,763,000 487,000 711,000 1,360,000 <u>2</u> /	11111	1,763,000 487,000 711,000 1,360,000 1,000	1,763,000 487,000 711,000 1,360,000 1,000	11111	11111	Maderate Mad
SUBTOTAL			9,383,000		4,322,000	0	4,322,000	4,322,000	•	0	
æ	29-1 29-4 29-5	MOO	102,000 2,601,000 434,000	<u> </u>	1,000 217,000 36,000	:::	1,000 217,000 36,000	992 215,555 35,759	1,445	:::	Moderate Low Low
SUBTOTAL			3,137,000		254,000	0	254,000	252,306	1,694	•	
30	30-1 30-3 30-4 30-6	2 11 11 11 11	7,219,000 102,000 43,700 208,000 153,000	6 2 2 10 15	241,000 1,000 3,000 77,000 85,000	11111	241,000 1,000 3,000 77,000 85,000	239,396 992 77,000	09°	3,000	Low Roderate Low Low
SUBTOTAL			7,725,700		407,000	6	407,000	317,388	1,612	88,000	
31	31-4	سا ك ك لد	13,500 351,000 707,000 437,000	ოოო ო	2,000 39,000 79,000 49,000	1111	2,000 39,000 79,000 49,000	1111	::::	25.000 29.000 27.000 49.000	Roderate Roderate Roderate
SUBTOTAL			1,508,500		169,000	0	169,000	0	0	169,000	

TABLE A-1 (Continued)
SECTION-BY-SECTION INITIAL MATERIAL MANDLING VOLUME ESTIMATES IN BANK CUBIC YARDS
(FROM DALF RMACCPMT, 1984/RIC 84034R01)

61,000 60,939 61 61,000 60,939 61 79,000 147,808 192 	Number	Site ID Mo.	Type	Area Type <u>l</u> /(Sq Ft)	Depth of Excavation (Ft)	Volume of Excavation	Equipment and Buildings Demolition	Total Volume	Volume of Toxic 254 Mazardous	Volume of	Volume of Surety	Begree of Confidence
35-16/2	*	32-1 32-5 32-6	000	94,000 166,000 213,000	20 20 20 20 20 20 20 20 20 20 20 20 20 2	8,000 61,000 79,000	:::	8,000 61,000 79,000	7,948 60,939 78,921	52 79	:::	Moderate Moderate Moderate
35-16/2	SUBTOTAL			473,000		148,000	6	148,000	147,808	192	0	
35-24/2	æ	35-16/	:	:	:	:	:	:	:	ŀ	:	:
35-7 7 12,600 10 5,000 -5,000		સું . સું	¦	: 56	; =		: :	: 66	13 65	: :	: :	-
35-6 E 96,000 2 1,000 1,000 69,572 458 35-7 K 2,246,600 118,000 0 118,000 117,535 465 36-1 A 5,369,000 10 2,289,000 12,913 67 2,00 36-2 E 1,171,000 2 13,000 12,913 67 67 36-3 C 1,171,000 2 13,000 12,913 67 67 36-4 A 130,000 10 2,289,000 23,000 23,000 23,000 12,913 67 36-4 A 130,000 10 46,000 2,000 2,000 10 10,000 2,000 2,000 1,000 10 10,000 10 10,000 10 10,000 10 10,000 10 10,000 10 10,000 10 10,000 10 10,000 10 10,000 10 10,000 10 <td< td=""><td></td><td>35-4</td><td>(7</td><td>12,600</td><td><u>. e</u></td><td>5,000 5,000</td><td>1 1</td><td>2000</td><td>200.5</td><td>: :</td><td>:</td><td>Noderate</td></td<>		35-4	(7	12,600	<u>. e</u>	5,000 5,000	1 1	2000	200.5	: :	:	Noderate
36-1 A 5,369,000 10 118,000 117,535 465 36-2 E 1,171,000 2,246,600 10 2,246,000 10 2,289,000 10 117,535 465 36-3 E 1,171,000 2 2,200		35-6	m 2	96,000	~ 4	1,000	• 1	00,1	993	~ 3	• 1	Moderate
36-1 A 5,369,000 10 2,289,000 115,000 12,913 465 36-2 E 1,171,000 2 2,289,000			:		•		1					•
36-1 A 5,369,000 10 2,289,000	UBTOTAL			2,246,600		118,000	0	118,000	117,535	465	•	
E 1,171,000 2 13,000 13,000 12,913 87 13,000 13,000 12,913 87 13,000 10 23,000 10 23,000 10 10 10 10 10 10 10 10 10 10 10 10	369/	36-1	<	5,369,000	2	2,289,000	•	2,289,000) - -	2,069,000	Pederate
C 61,000 10 23,000		36-2	W	1,171,000	~;	13,000	•	13,000	12,913	87	•	Moderate
1,000 1,00		9e	۰ د	61,000	25	23,000	• 1	23,000 4,000 5,000	23,000	: 1	: 1	
E 147,000 2 2,000 229,000 229,000 229,000 229,000 229,000 22,000 229,000 22,000 2,000 1,969 111			<	22,000	25		: :	000		:	:	
I 617,000 10 229,000 229,000 J 22,200 10 8,000 6,000 1,969 11 E 152,000 2 2,000 2,000 1,969 11 C 173,000 10 64,000 64,000 64,000 C 180,000 10 44,000 44,000 44,000 C 180,000 10 7,000 7,000 7,000 C 58,000 10 21,000 2,000 7,000 D 7,000 7,000 2,000 C 77,001 10 7,000 4,000 C 77,001 10 7,000 2,603,000 C 77,001 7,000 2,603,000 </td <td></td> <td>36-6</td> <td>نعا د</td> <td>147,000</td> <td>~</td> <td>2,000</td> <td>•</td> <td>2,000</td> <td>2,000</td> <td>:</td> <td>:</td> <td>3</td>		36-6	نعا د	147,000	~	2,000	•	2,000	2,000	:	:	3
J 22,200 10 8,000 6,000 1,969 11 E 152,000 2,000 1,969 11 C 173,000 10 64,000 64,000 C 120,000 10 38,000 44,000 C 18,000 10 7,000 7,000 C 58,000 10 7,000 7,000 D 728,000 10 7,000 4,000 C 77,001 10 7,000 2,603,00 C 4,000 2,603,00 2,603,00		36-7	-	617,000	2		:	229,000	229,000	:	:	Moderate
E 152,000 2 2,000 1,989 11 173,000 10 64,000 64,000 64,000 1,989 11 20,000 10 38,000 44,000 10 10 7,000 10 7,000 10 10 1,000 10 10 1,000 1,000 10		36-8	7	22,200	2	9000	:	8,000	9,000	1:	:	Moderate
A 102,000 10 38,000 38,000 38,000 44,000 44,000 7,000 7,000 7,000 7,000 <td< td=""><td></td><td>6-96 6-97 6-97</td><td>w C</td><td>152,000</td><td>~ 5</td><td>2,000</td><td>: 1</td><td>25.00</td><td>200.13</td><td>=</td><td>: :</td><td>Modern to</td></td<>		6-96 6-97 6-97	w C	152,000	~ 5	2,000	: 1	25.00	200.13	=	: :	Modern to
C 120,000 10 44,000 44,000 44,000 7,000		36-11	> <	102,000	2,2	38,000	•	38,000	38,000	:	:	Poterate
C 18,000 10 7,000 7,000 7,000 C 15,000 10 7,000 C 1,000 10 7,000 10 10 7,000 10 10 7,000 10 10 7,000 10 10 7,000 10 10 7,000 10 10 7,000 10 10 7,000 10 10 7,000 10 10 7,000 10 10 7,000 10 10 7,000 10 7		36-12	ں:	120,000	2	4,000	:	4	44,000	:	:	Noderate
C 58,000 10 21,000 21,000 7,000 6,953 47 C 77,001 10 4,000 4,000 3,971 29 C 4,685,000 15 2,603,000 2,603 2,6		36-13	U	18,000	2	2,000	:	2,000	2,000	:	:	Noderate
D 128,000 10 7,000 7,000 6,953 47 C 77,001 10 4,000 4,000 3,971 29 C 4,685,000 15 2,603,000 2,603,000 2,603		36-14	U	28 ,000	2	21,000	:	21,000	:	:	2,000	Moderate
2, 1/2,007 4,000 2,603,000 2,603,000 2,603		36-15	٥,	128,000	٥:	2,900	:	, 990 , 990 , 990	6,953	7	:	Noderate
2,685,000 15 2,603,000 2,603,000 2,603		36-16	۰	200,77	2:	000.4	:		3,9/1			MODEL STE
1 000 t 000 t		36-17	، ن	4, 685, 530	<u>.</u>	2,603,000	:	2,603,000	: 8	2,603	7,600,397	3 2

TABLE A-1 (Continued)
SECTION-BY-SECTION INITIAL MATERIAL MANDLING VOLUME ESTIMATES IN BANK CUBIC YARDS
(FROM DALF RMACCPMT, 1984/RIC 84034R01)

Section Number	Site ID No.	Area Type <u>l</u> /(Sq Ft)	Depth of Excavation (Ft)	Volume of Excavation	Volume of Equipment and Buildings Demolition	Total Volume	Volume of Toxic and Hazardous	Volume of Volume of UXC2/ Surety	Volume of Surety	Degree of Confidence
	36-19 36-20	6 305,000 6 12,000	00 01 21	113,000	;;	113,000	113,000 7,000	::	::	Moderate Moderate
SUBTOTAL		13,381,600	18	5,526,000	9	5,526,000	812,826	2,777	4,710,397	
TOTAL		55,873,695	96	15,818,000	65,010	15,883,010	15,883,010 10,291,338 6,765	6,765	5,584,907	

To be relocated into Site 36-1 under baseline actions.

Includes contaminated buildings 412, 413, 422, 424, 425, 426, 427, 429, 431, 512, 514, 516, 521, 522, 523, 5234, 525, 526, 536, 537, 538, 541, and 742.

Includes contaminated buildings 242, 243, 331, 343, 344, 345, and 346.

To be relocated into Site 26-6 under baseline actions.

Includes additional volume from baseline actions.

Previously relocated into Site 26-6 under baseline actions. Due to shallow depth to groundwater, some sites have a limited depth of excavation. Includes additional volume from baseline actions. Contaminated type classification described in Table A-1.

	DALF	ESE Tasks Update 1, 6,	Ebasco Tasks Update 2,7,10,11,			Volume Estimate	
Site 10	Total Volume (BCY)*	14, 21 (BCY)*	12,15,17,24,or 34 (BCY)*	RMA Task Number	Expected (BCY)*	Expanded (LCY)+	*(Y22)
1	43,000	:	58,000	^	58.000	66.70	55. 100
1-2	:	:	NA.	12	MA.	-	•
	:	:	2,460	~	2,500	2,900	2.400
7	:	:	3	~	:	:	:
- <u>s</u>	53,000	:	-42	~	53.000	61.000	
1-7	77,000	:	2,600***	11, 34	NA.	2,600**	_
<u>-</u>	33,000	:	*VI	~	33,000	38,000	31,400
<u></u>	:	:	13,900	^	13,900	16,000	
01-1	175,000	:	***	~	175,000	201,300	
==	:	:	*Y#	~	-	•	
1-12	4,000	:	*YE	12	44,000	50,600	41,800
1-13	1,778,000	:	NA*	·~	1,778,000	2.044.700	1.689.100
Buildings	23,400	:	*42	24	23,400	35,100	28, 100
UNC-1*	•	:	NA.	^	HA*	¥ H	N. A.
		1					
Subtota 1	2,226,400	:	76,960		2, 180, 800	2,518,900	. 2,079,900
1-2	66,000	:	NA•	^	66.000	75.900	62.700
2-2	000	:	•	~	1,000	1.200	1,000
2-3	18,000	:	13,700	~	13,700	15,800	13,000
2-4	:	:	•00	2	:	:	:
2-5	:	:	NA*	~	NA.	¥	**
5- 6	21,000	:	NA*	~	21,000	24,200	20,000
2-1	14,000	:	1,100	~	90.	300	000,
8-2	:	:	NA.	~	***	**	· VN
5-9	:	:	39,000	~	39,000	44,900	37,100
2-15	:	:	2, 100	~	2,100	2,400	2,000
2-13	:	:	\$	~	:	:	:
2-14	73,000	:	19,800	~	19,800	22,800	18,900
2-17	233,000	:	***	~	233,000	268,000	221,400
2-18	1,307,000	:	*	~;	1,307,000	1,503,100	1,241,700
Bufldings	12,310	:	• 4 2 :	7	12,300	18,500	2,800
UNC-2*		•	*	^	¥	*	4
Subtote1	1,745,310	:	55,900		1,716,000	1,978,100	1,633,500

^{*(}BCY): Bank Cubic Yards; (LCY): Loose Cubic Yards; (CCY): Compacted Cubic Yards; (UNC): Uncontaminated Areas; (NA): Volume Estimate not available at 2/6/87; (CU): Considered uncontaminated or no Phase II investigations planned as of 2/6/87.

**Volume Estimates rounded to mearest 100 bcy based on current RI/FS studies or the DALF.

***Loose cubic yards of building debris from Ebasco (1987c). Soil volume estimate not available as of 2/6/87.

Site 10	DALF Total Volume (BCY)*	ESE Tasks Update 1, 6, 14, 21 (BCY)*	Ebasco Tasks Update 2,7,10,11, 12,15,17,24,or 34 (BCY)*	RMA Task Number	Expected (BCY)*	Volume Estimates** Expanded (LCV)*	*(733)
3-1 3-2 3-3 3-4 3-4 Buildings UNC-3* Subtotal	15,000	:::::	31,000 16,800 16,800 18A* CU* 47,800	10 7 7 7 24 15	31,000 16,800 18,800 14,800	35,700 19,300 NA*	29,500 16,000 16,000 18*
4-1 4-2 4-3 4-4 4-5 4-6 Buildings UNC-4* Subtotal	57,000 68,000 249,000 249,000 	:::::::::::::::::::::::::::::::::::::::	9,000 22,000 84,000 164,000 NA* NA* 195,000	5 11 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	9,000 22,000 249,000 164,000 184*	10,400 25,300 286,400 188,600 184* 114* 114*	8,600 20,900 236,600 155,800 IRA- RA-
5-2 Buildings UNC-5* Subtotal	147,000	::: :	MA*	22 22 31	147,000 NA*	169, 100 NA+ 169, 100	139,700 NA*
6-2 6-5 6-6 Buildings UNC-6* Subtotal	96,000	::::: :	CURRE	212 22 24 25 25 25 25 25 25 25 25 25 25 25 25 25	1,000 96,000 NA*	1,200 110,400 110,400 111,600	92,70 92,70 92,70

^{*(}BCV): Bank Cubic Vards; (LCV): Loose Cubic Vards; (CCV): Compacted Cubic Vards; (UNC): Uncontaminated Neas; (NA): Volume Estimate not available at 2/6/87; (CU): Considered uncontaminated or no Phase II investigations planned as of 2/6/87.

**Volume Estimates rounded to mearest 100 bcy based on current RI/FS studies or the DALF.

***Site 3-2 is included in Site 3-3 (Ebasco, 1986p).

	DALF	ESE Tasks Update 1, 6.	Ebasco Tasks Update 2,7,10,11,		·	Volume Estimates**	
Site 10	Total Volume (BCY)*	14, 21 (BCY)*	12,15,17,24,or 34 (BCY)*	RMA Task Number	Expected (BCY)*	(ICY)*	UTSPOSET (CCY)*
Buildings UNC-7• Subtotal		: : :	** :	24 15	; š ;	; š :	 š
Buildings UNC-8* Subtotel	: : :	: : :	3 * :	22 25	:≛ :	Š	: š :
Buildings UNC-9* Subtotal		: : :	÷ ¥ :	24 15	: ¥ :	; š ;	: <u>\$</u> :
11-1 Buildings UNC-11* Subtotel	53,000	11111	**** :	22 22 24 24 15	53,000 NA*	61,000 NA*	50,400 RA*
12-1 12-2 Buildings UNC-12* Subtote1	55,000 64,000 	111111	180,000 NA* NA* CU* 180,000	22 22 35 35	160,000 64,000 NA*	207,000 73,600 MA*	171,000 60,800 8A* 231,800

*(DCV): Bank Cubic Yards; (LCY): Loose Cubic Yards; (CCV): Compacted Cubic Yards; (UNC): Uncontaminated Areas; (NA): Volume Estimate not available at 2/6/87; (CU): Considered uncontaminated or no Phase II investigations planned as of 2/6/87.

**Volume Estimates rounded to nearest 100 bcy based on current RI/FS studies or the DALF.

Site ID	DALF Totel Volume (BCY)*	ESE Tasks Update 1, 6, 14, 2) (BCY)*	Ebasco Tasks Update 2,7,10,11, 12,15,17,24,or 34 (BCY)*	RMA Task Number	*(BCV)*	Volume Estimptes** Expanded (LCY)*	*(Y2) *(CCY)*
19-1 Buildings UNC-19* Subtotal	1,000	*/D	**: :	25 24 24	1,000 HA* 1,000	1,200 HA+ 	1,000 IA.
20-1 Buildings UMC-20* Subtotal	1,000	- KA :	1 2 1	14 24	1,000 NA* KA*	1,200 NA* NA* 1,200	1,000 RA* RA*
Buildings UNC-22 Subtotel	** *	- HA	*** :- :-	24	HA*	HA.	RA*
Buildings UNC-23 Subtotal	: : :	: #¥ :	### : :	24 14	HA*	HA+ HA+	HA*
24-5 24-6 24-7 Buildings UNC-24* Subtotal	96,000	:::=	EU*	10 7 7 24 14	86,000 184* 184*	110,400 110,400 110,400	91,200 RA* RA* BA*

*(DCY): Bank Cubic Yards; (LCY): Loose Cubic Yards; (CCY): Compacted Cubic Yards; (UNC): Uncontaminated Areas; (NA): Volume Estimate not available at 2/6/87; (CU): Considered uncontaminated or no Phase II investigations planned as of 2/6/87.

**Volume Estimates rounded to nearest 100 bcy based on current RI/FS studies or the DALF.

	DALF	ESE Tasks Update 1, 6,	Ebasco Tasks Update 2,7,10,11,			Volume Est im etes**	
Site 10	Total Volume (BCY)*	14, 21 (8CY)*	12,15,17,24,or 34 (8CY)*	RMA Task Number	Expected (BCY)*	Expanded (LCY)*	UTSPOSET (CCV)*
25-2	9.000	:	*V	2	9	9.90	SK S
25-3	12,000	:	· VE	2	12,000	13,800	5
25-4	***	:	•••	75	**		
25-5	#	:	••	72	•		
25-6	•	:	::	72	*		
25-7	•	:	•••	2	*		
25-8	***	:	:	2	*		
25-9	***	:	:	72	*		
25-10	*	:	•••	72	•		
25-11	#	:	••	54	•		
25-12	**	:	:	2	•		
25-13	**	:	***	5 2	•		
25-14	***	:	:	24	•		
25-15	***	:	:	5 2	*		
25-16	:	:	:	2	:		
Buildings	29,300	:	KA*	72	29,300	44,000	35,200
UNC-25+	:	Ž	:	=	\$	\$	Š
6.44.44.9	200					3	3
Subtote	47,500	•	•		4/, 300	64. /00	92,300
7-1	•	₩.	•	æ	HA*	•	, All
26-3	1.763.000	*	:	•	1.763.000	2,027,500	1.674.900
7-92	487,000	162.000	;	•	162,000	•	153,900
26-5	711,000	711,000		•	711,000	817,700	675,500
56-6	1.360,000	#VH	:	•	1,360,000	2,720,000	2,720,000
26-7	000	***	:	•		:	:
56-8	:	:	. •W	2	•	į	į
56-9	:	:	#Y#	2	*	ž	į
But 1d Ings	:	:	*Y	5 2	*	\$	***
UNC-26*	:	*	'	•	¥	¥¥	3
Subtotal	4,322,000	873,000	:		3,996,000	5,751,500	5,224,300
		•			•	.	•

^{*(}BCY): Bank Cubic Vards; (LCV): Loose Cubic Vards; (CCV): Compacted Cubic Tards; (UMC): Uncontaminated Areas; (MA): Volume Estimate not available at 2/6/87; (CU): Considered uncontaminated or no Phase II investigations planned as of 2/6/87.
**Volume Estimates rounded to nearest 100 bcy based on current RI/FS studies or the DALF.
***Building Sites are summarized under buildings for this section.
****Site 26-7 Basin B and C Drainage included with Site 35-4.

Site ID	DALF Total Volume (BCY)*	ESE Tasks Update 1, 6, 14, 21 (BCY)*	Ebasco Tasks Update 2,7,10,11, 12,15,17,24,or 34 (BCY)*	RMA Task Number	Expected (BCY)*	Volume Estimates Expanded (LCV)+	*(Y))
Buildings UNC-27* Subtotal	: : :	: 5 :	*: :	24 14	* : :	غ : :	\$: :
Buildings UNC-28* Subtotel	: : :	HA*	ž: :	25	AH :	** :	ji
29-1 29-4 29-5 Buildings UNC-29* Subtotal	1,000 217,000 36,000	3,200 31,000 CU* CU*	:::\$: :	22222	3,200 31,000 NA*	3,700 35,700 18.400	3,000 29,500 NA*
30-1 30-2 30-3 30-4 30-5 30-6 But 1dings UNC-30*	241,000 1,000 77,000 85,000	68,000*** 2,300 3,000 13,300 INA**	1::\$::\$:	2227222	68,000 2,300 3,000 77,000 13,300 18,4	78,200 3,500 88,600 15,300 184,200	64,600 2,200 2,900 73,200 12,600 8AA 155,500

*(BCY): Bank Cubic Yards; (LCY): Loose Cubic Yards; (CCY): Compacted Cubic Yards; (UNC): Uncontaminated Areas; (NA): Volume Estimate not available at 2/6/87; (CU): Considered uncontaminated or no Phase II investigations planned as of 2/6/87.
**Yolume Estimates rounded to nearest 100 bcy based on current RI/FS studies or the DALF.
***67,500 bcy hazardous waste and 450 bcy UXO (ESE, 1986q).

	DALF	ESE Tasks Update 1, 6,	Ebasco Tasks Update 2,7,10,11,			Volume Estimates**	
Site ID	Total Volume (BCY)*	14, 21 (6CY)*	12,15,17,24,or 34 (BCY)*	RMA Task Number	Expected (BCY)*	Expanded (LCY)*	Disposat (CCY)*
31-2	2.000	:	• WW	15	2.000	2.300	99.
31-4	39,000	;	NA.	5	39,000	44,900	37,100
31-6	79,000	:	*YZ	5	79,000	90,900	75, 100
31-7	49,000	:	***	<u>5</u>	49,000	56,400	46,600
31-8 But 14tmes	: :	: :	• 4 4 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	25	***		¥ ;
UNC-31*	:	:	*00	15	K .	E .	
Subtotal	169,000	:	;		169,000	194,500	160,700
32-1	8.000	***		7	•	:	:
32-5	61,000	:	HA•	15	61,000	70,200	\$8,000
32-6	79,000	:	* A *	35	79,000	90,900	75, 100
UNC-32*		: :	Z X	15	ZZ Z	ŽŽ	ŽŽ
Subtotel	148,000	:	:		140,000	161,100	133,100
Dufldings UNC-33*	::	::	*¥5	2 52	ž:	MA.	HA.
				•		1	
Subtota 1	:	:	:		:	:	:

*(BCY): Bank Cubic Vards; (LCY): Loose Cubic Yards; (CCY): Compacted Cubic Yards; (UNC): Uncontaminated Areas; (NA): Volume Estimate not available at 2/6/87; (CU): Considered uncontaminated or no Phase II investigations planned as of 2/6/87.

**Volume Estimates rounded to mearest 100 bcy based on current RI/FS studies or the DALF.

***Site 32-1 volume estimate incorporated into Site 29-5.

	DALF	ESE Tasks Update 1, 6,	Ebasco Tasks Update 2,7,10,11,		*	Volume Estimates	
Site 10	Total Volume (BCY)*	14, 21 (BCY)*	12, 15, 17, 24, or 34 (BCY)*	RMA Task Number	Expected (BCY)*	Expanded (LCY)*	Traposat (CCY)*
34-2 Buildings UNC-34* Subtotal	; ; ; ;	::\$:	##: :	2.2.2	AN AN AN AN	***	111
35-1 35-2 35-3 35-4 35-6 35-7 But1dings	43,000 5,000 1,000 69,000	10,000 10,000 CU*		5500444	43.000 10.000 69.000	49,500 11,500 11,500 14,500	40.900 9,500 65,600
Subtotal	118,000	53,000	:		122,000	140,400	116,900

Site 10	DALF Total Volume (BCY)*	ESE Tesks Update 1, 6, 14, 21 (BCY)*	Ebasco Tasks Update 2,7,10,11, 12,15,17,24,or 34 (BCY)*	RMA Task Number	Expected (BCY)*	Volume Estimptes** Expended (LCY)*	Disposat (CCV)*
36-1	2.289.000	585,000	•	-	585.000	672.800	555.800
36-2		*W	:	=	13,000	5.00	12,400
36-3	23,000	¥	:	·	23.000	26,500	21.900
36-4	48,000	82,000	;		82,000	94,300	77.900
36-5	000	*VA	:	_	000	1,200	900
36-6	2,000	6, 200	:	=	6,200	7,100	2,900
26-7	229,000	26,000	:	_	26,000	29,900	24,700
36-8	8,000	12,000	:	_	12,000	13,800	11,400
36-9	2,000	HA*	:	=	2,000	2,700	1,900
36-10	~	RA*	:	-	64,000	73,600	000.09
36-11	38,000	15,500	:	-	15,500	17,800	14,700
36-12	٦.	WA*	:	_	44,000	50,600	41,800
36-13	2,000	*4	:	=	2,000	8, 100	6,700
36-14	21,000	#¥#	;	=	21,000	24,200	20,000
36-15	2,000	000.4	:	-	900.	4 ,600	3,800
36-16	٦.	NA*	:	=	90.4	600	3,800
36-17	2,603,000	****	:	_	2,603,000	2,993,500	2,472,900
36-18	~	.	;	=	:	:	:
36-19	113,000	#A#	:	=	113,000	130,000	107,400
36-20	2,000	9,000	:	-	9	6,900	5,700
36-21	:	1,200	:	_	1,200	1,400	90.
36-22	:	NA*	•	-	*VII	· VII	**
36-23	:	#¥#	:	-	*4	#¥	*A*
Butldings	:	:	*4	* 2	¥	**************************************	¥
UNC-36*	:	¥	:	_	¥	ž	\$
Subtotal	5,526,000	737,900	:		3,632,900	4,178,200	3,451,600
		•	•			•	•

*(BCY): Bank Cubic Yards; (LCY): Loose Cubic Yards; (CCY): Compacted Cubic Yards; (UMC): Uncontaminated Areas; (NA): Volume Estimate not available at 2/6/87; (CU): Considered uncontaminated or no Phase II investigations planned as of 2/6/87.

** Volume Estimates rounded to nearest 100 bcy based on current RI/FS studies or the DALF.

*** Yolume Estimate not available as of 2/6/87, however, surety contaminated material may be present at this site.

	DAIF	ESE Tesks Undate 1. 6.	Ebasco Tasks Undate 2.7.10.11.			Volume Estimates	9.1
Site 10	Total Volume (BCY)*	14, 21 (BCY)*	12,15,17,24,or 34 (BCY)*	RMA Task Number	Expected (BCY)*	Expanded D (LCY)*	Disposal (CCV)*
South Plants Regional	:		NA*	2	NA*	MA*	HA.
Spill Sites Subtotal	: :	: :	- HA	2	¥ i	NA :	NA*
TOTAL	15,818,000	1,782,700	533,060		13,332,600	16,515,800	14,114,100

*(BCY): Bank Cubic Yards; (LCY): Loose Cubic Yards; (CCY): Compacted Cubic Yards; (UMC): Uncontaminated Areas; (NA): Yolume Estimate not available at 2/6/87; (CU): Considered uncontaminated or no Phase II investigations planned as of 2/6/87.

** Yolume Estimates rounded to nearest 100 bcy based on current RI/FS Studies or the DALF.

Comment	Separate CAR Report.
Task Number	722221 2222222222222222
Tricolor Map <mark>l</mark> / Designation	2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.
Site Name	Drainage Ditches Upper and Lower Derby Lakes Wounded Material Borrow Pit Revetted Storage Areas Hydrazine Blending and Storage Salvage Yard Open Storage Area South Tank Storage Area Sanitary Landfill Trash Dump South Plants Area Drainage Ditches Firebreak Lagoon Excavation or Ground Scar Trench Salt Storage Area Aeration Basin Former Tank Storage Area Open Storage Area Location for Former Tanks Former Open Storage Area Ladora Lake and M.ry Lake Sanitary Landfill Ladora Lake and Overflow Basin (includes 3-3)
Site Number or Designation	2-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1

^{1/} Campbell and Witt. September, 1983. Selection of a Contamination Control Strategy for Rocky Mountain Arsenal.
2 vols. USATHAMA Final Report, RIC No. 83326ROI. 1 in = 1,000 ft Color Map, titled Areas Investigated as Potential Contamination Sites on RMA.

Site Number or Designation	Site Name	Tricolor Map Designation	Task Number	Comment
3-4	Nemagon Spill Area	Pink	7	Separate CAR Report.
4-2		Pink	15	CAR
4-3		Pink	15	CAR
4-4	Burning Pits	Pink	15	CAR
4-5	Borrow Pit	Blue	15	CAR
9-6	Motor Pool Area	None	38	CAR
2-5	Area of Potential H and HD Contamination	Pink	15	CAR
2-9 -	rby Lake		12	CAR
6-5	_	Pink	15	onsic
9-9	oxic	Pink	15	
	Lake Sludg	Pirk	12	CAR
15-1	Sludg	Pink	12	CAR
12-2	nd Gun	Pizk	12	CAR
19-1	Burn Site	Pink	14	CAR
20-1	Si	Pirk	14	CAR
24-6	Sewage Treatment Plant and Ponds	Pink	7	ite CAR
24-7	North Bog	None	7	te; S
26-3	Basin C	Pink	9	CAR
26-4	Basin D	Pink	9	CAR
5 -5	Basin E	Pink	9	CAR
59-6		Pirk	9	CAR
7-92	Surface Drainage from Basin A	Pink	9	CAR
29-1	Burn Site	Pink	7	CAR
29-4	Area	Pink	74	CAR
29-5	Disposal Site (includes 32.01)	Pirk	14	CAR
30-1	Impact Area	Pirk	74	CAR
30-2	Burn Site	Pink	14	CAR
30-3	H Training Area	Pink	14	CAR
30-4	Sanitary Landfill	Pink	7	e CAR
30-5	Demil Operation Area	Pirk	14	₹ 2
30-6	Trenches	Pink	14	e CAR
30-7	Ground Disturbance	Pink	14	Separate CAR Report.

TABLE A-3 (Continued)

Comment	May be considered uncontaminated. Separate CAR Report.
Task Number	2225500044-44444-4-4
Tricolor Map Designation	ZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZ
Site Name	VX and GB Soil Contamination New Toxic Gas Storage Yard Storage Sheds Storage Shed Burning Pits Burning Pits Burning Pits Basin B Drainage from Basin A Munitions Test Area Firing Range Basin A Incendiary Drop and Munitions Test Area Insecticide Pits Lime Settling Basins Mercury Compound Spill Probable Test Site Sanitary and Shell Disposal Sites Open Chemical Drainage Incendiary or Munitions Test Site Large Pit Liquid Storage Pools Pits or Trenches Irenches Disposal Site Burning Site Complex Disposal/Activity Sites Ground Scars Chemical Sewer Line
Site Number or Designation	31-2 31-4 31-4 32-5 32-5 35-6 35-1 36-2 36-8 36-8 36-1 36-1 36-1 36-1 36-1 36-1 36-1 36-1

TABLE A-3 (Continued)

Site Number or Designation	Site Name	Tricolor Map Designation	Task Number	Comment
36-23	Debris Pile from Basin A	None	_	"New" Site: Separate CAR Report.
1-UNC	Uncontaminated Areas	· None	7	te CAR Report.
9-1	Open Storage Area	Blue	7	in
2-UNC	Uncontaminated Areas	None	7	CAR Report.
2-10	Ground Scar	Blue	7	÷
2-11	Open Storage	Blue	7	in uncontaminated
2-15	Open Storage Area	Blue	7	in uncontaminated
2-16	Pit	Blue	7	in uncontaminated areas
3-UNC	Uncontaminated Area	None	15	CAR Report.
4-UNC	Uncontaminated Area	None	15	CAR
5-UNC	Uncontaminated Area	None	15	CAR
5-1	Bomb Storage Sites	Blue	15	in c
9-UNC	Uncontaminated Area	None	15	Separate CAR Report.
[-9	Drainage Ditches	Blue	15	in c
6-3	Storage Area	Blue	15	Included in uncontaminated areas.
6-4	Salt from Mustard Demil	Blue	15	Included in uncontaminated areas.
2-9	HE Storage Yard	Blue	15	Included in uncontaminated areas.
8-9	Storage Sheds or Bunkers	Blue	15	Included in uncontaminated areas.
6-9	Vegetation Stress	Blue	15	Included in uncontaminated areas.
01-9	Trenches	Blue	15	Included in uncontaminated areas.
6-11	Trench	Blue	15	Included in uncontaminated areas.
6-12	Possible Excavation	Blue	15	Included in uncontaminated areas.
6-13	Excavation	Blue	15	Included in uncontaminated areas.
6-14	Open Storage	Blue	15	Included in uncontaminated areas.
6-15	Stoage Sheds	Blue	15	Included in uncontaminated areas.
7-UNC	Uncontaminated Areas	None	15	Separate CAR Report.
ו-2	Bomb Storage Sheds	Blue	15	in
8-UNC	Uncontaminated Areas	None	15	CAR Report.
8-1	Bomb Storage Sheds	Blue	15	i
9-UNC	Uncontaminated Areas	None	15	Separate CAR Report.
9-1	Ground Disturbance, Radio Tower	Blue	15	Included in uncontaminated areas.
0-2	Excavation or Mound	Rlife	ا ت	Included in uncontaminated areas.

TABLE A-3 (Continued)

	ated areas.	ated areas. ated areas.	ated areas. ated areas. ated areas.	ated areas. ated areas. ated areas.			ated areas. ated areas. ated areas.
Comment	CAR Report. in uncontaminated CAR Report.	\$ = \$ = \$	25	CAR Report. in uncontaminated in uncontaminated in uncontaminated in uncontaminated	\$ - \$ - - =	±2===	CAR Report. CAR Report. In uncontaminated in uncontaminated in uncontaminated CAR Report.
	Separate Included Separate	Included Separate Included Separate	Separate Included Included	Separate Included Included Included Included	Separate Included Separate Included	Included Separate Included Included	Separate Separate Included Included Included
Task Number	15 25 4	4444	4444	4444	44000	04444	44444
Tricolor Map Designation	None Blue None	None Range	None Blue Blue	None Blue Blue Blue	None Blue Pink Blue	Mone Mone Blue Blue	None None Blue Blue
Site Name	Uncontaminated Areas Disturbed Area Uncontaminated Areas	o o	Uncontaminated Areas Suspected TX Disposal Well Suspected TX Disposal Well TX Production Site	Uncontaminated Areas Suspected TX Burial Site Suspected TX Disposal Well Suspected TX Disposal Well TX Production Area	Uncontaminated Areas TX Production Area Uncontaminated Areas Deep Disposal Well TX Production Area	Lined Pond Uncontaminated Areas Basin G Ground Scar Ground Scar	Uncontaminated Areas Uncontaminated Areas Ground Disturbances Burn Site Ground Disturbance Uncontaminated Areas
Site Number or Designation	11-UNC 11-2 12-UNC	19-2 20-UNC 20-2 22-UNC	23-1 23-2 23-3	24-UNC 24-1 24-3 24-4	25-UNC 25-1 26-UNC 26-1	26-10 27-1 27-2 27-2 27-3	28-UNC 29-2 29-3 29-6 30-UNC

TABLE A-3 (Continued)

Site Number or Designation	Site Name	Tricolor Map Designation	Task Number	Comment
31-UNC	Uncontaminated Areas	None	15	Separate CAR Report.
31-1	Storage Sheds	Blue	15	=
31-3	Warehouse	Blue	15	in uncontaminated areas
31-5	Disturbed Ground	Blue	15	in uncontaminated areas
31-UNC	Uncontaminated Areas	None	15	Separate CAR Report.
32-2	Ground Scars	Blue	15	i E
32-3	Open Storage Areas	Blue	15	in uncontaminated
32-4	Storage Shed	Blue	15	Included in uncontaminated areas.
32-7	Storage Sheds	Blue	15	Included in uncontaminated areas.
32-8	Ground Disturbance	Blue	15	Included in uncontaminated areas.
33-UNC	Uncontaminated Areas	None	15	
34-UNC	Uncontaminated Areas	None	-	CAR
34-3 (?)	Scarified Ground	Blue	14	
35-UNC	Uncontaminated Areas	None	9	Separate CAR Report.
35-5	Ground Disturbance	Blue	9	Ę
35-8	Storage Area	Blue	9	Included in uncontaminated areas.
35-9	Caustic Holding Basin	Blue	9	É
36-UNC	Uncontaminated Areas	None	_	CAR Report.
South Plants	Manufacturing Area	Misc.	2	Separate South Plants Area CAR
regional		1 4 4 4	•	440
Spill Sites		AT SC.	7	Spill Sites CA
but i angs	Arsenal-Wide	MISC.	4 6	Bulldings CAK
25=5		Pink	24	Constste Building CAR Beaut
25-6	Building 1504	Pirk	24	Buildings CAR
25-7		Pink	24	Buildings CAR
25-8	_	Pink	24	Buildings CAR
52-9	_	Pirk	24	Buildings CAR
25-10	But1ding 1606	Pink	24	Buildings CAR
25-11	=	Pink	24	Bufldings CAR
25-12	_	Pirk	24	Buildings CAR
25-13	Building 1616	Pink	24	Separate Buildings CAR Report.

TABLE A-3 (Continued)

APPENDIX II

LAND DISPOSAL CONCEPTS

II.0 LAND DISPOSAL CONCEPTS

This Appendix reviews the technology available for waste disposal facilities. Causes of failure and success at existing facilities are discussed, the state-of-the-art in facility design, construction and operation is presented, and examples of facilities having particular relevance to RMA are examined individually. The failure review and state-of-the-art discussions are drawn from EPA studies and guidance documents. The example facilities descriptions are based on review of the design and licensing documents for those facilities.

II.1 GENERAL

Land disposal practices have evolved over the years from municipal open dumps, to landfills, to the present practice of incineration or other treatment of municipal, hazardous, and nuclear wastes followed by land disposal in engineered facilities.

Old landfills, including many still in operation, were often developed with little regard for engineering considerations of the site, such as soil type and groundwater conditions. Landfills were developed in excavated pits or natural depressions with uncontrolled waste placed in them and not covered on a daily basis. Large quantities of hazardous materials were often disposed in municipal landfills. As a result, severe environmental damage resulted from rainfall percolating through the waste and leaching into the water table. Once entering the water table, the leachate migrated off-site and in many cases contaminated surrounding wells or surface water sources. Failure to minimize and control leachate production was the primary cause of environmental damage from sanitary landfills. The lack of proper design meant limited removal of leachate before it intercepted the water table. If designs did provide for leachate removal, they often provided no means to detect failure of the system until environmental damage had been done (i.e., water supply sources contaminated).

Potential and actual adverse public health effects caused by landfills gave rise to the regulation of landfills and the development of engineering concepts of land disposal facility design and operation. Siting came to

include consideration of potential impact to groundwater, reliable containment, and methods of operation that would reduce potential adverse effects. Engineered landfills involved a more technical approach, including assessments of water table elevations, soil sampling and testing, and design of new features of the waste pit such as clay or flexible membrane liners.

As regulated disposal of hazardous waste in land disposal sites has expanded, new sites have incorporated various improvements. The improvements over prior facilities included such things as multiple liner systems, leachate collection and treatment systems, gas collection systems, and improved covering techniques. A review of land disposal facility failures and the state-of-the-art design responses to these failures follows.

The waste cell concepts for the Rocky Mountain Arsenal will reflect the state-of-the-art techniques in containment of hazardous wastes for the protection of the environment.

II.2 REVIEW OF FAILURE STUDIES

II.2.1 General

The Environmental Protection Agency has conducted studies of land disposal facilities based on survey information supplied by vendors and facility operators (Arthur D. Little, Inc., 1985b; EPA, 1985a). Because of the relatively recent introduction of synthetic membrane liners and complex engineered disposal facilities, there are few long-term case studies of such projects available. The long-term case studies generally consist of older, unlined projects, which have experienced problems such as groundwater contamination as time progressed. This section provides information on the various modes of failure that have occurred at land disposal facilities and concludes with factors that have contributed to successes.

II.2.2 Failure Mechanisms

II.2.2.1 Design

One of the basic factors leading to failure of a land disposal facility has been poor or inadequate design:

- The subgrade material or material between liners was too coarse and failure occurred as a result of puncture;
- o Leachate collection system was undersized;
- o Improper liner selection based on liner compatibility with the waste;
- o Lack of adequate run-on and runoff control; and
- o Lack of adequate gas collection systems.

II.2.2.2 Quality Control

EPA studies suggest that lack of quality control in installation is one of the major causes of failures in liner systems and in land disposal facilities.

This lack of quality control includes:

- o Poor bonding at seams between liner panels;
- o Liners placed over or between coarse rock;
- Thin soil cover over liners resulting in punctures by heavy equipment; and
- o Work not meeting design specifications generally.

II.2.2.3 Physical Failure

There are a number of modes of liner failure due to physical processes and stresses:

Puncture or tear failure can occur in liners under certain circumstances. It can occur due to improper placement of synthetic liners directly over or between coarse materials, long term migration of fine materials exposing the liner to sharp rocks in the subgrade, operations by equipment such as bulldozers, and occasionally

intrusion by hoofed animals when cover soils are too thin.

- o Failure resulting from creep is caused by a sustained load with increasing deformation of the liner material.
- o Liners exposed to freeze-thaw cycles can undergo cracking as a result of liquid volume expansion in pore spaces during freeze cycles.
- o Wet-dry cycle cracking is associated with clay liners exposed to weathering.
- o Differential settling typically occurs when foundations are improperly prepared.
- o Thermal stress results from temperature gradients that cause volume changes in the liner material when they are exposed to weathering.
- o Hydrostatic pressure from uncontrolled liquid levels inside or outside a cell or a liner can result in failure.
- o Abrasion can cause significant wear to an exposed liner over time, which can lead to failure.

II.2.2.4 Biological Failure

Biological modes of failure may consist of microbial or small animal attack. Small animals may attack synthetic membrane liners and eat them. Clay liners may be penetrated by burrowing animals.

II.2.2.5 Chemical Failure

Failures of liners because of chemical reactions occur because hazardous wastes contained in disposal facilities may be composed of organic and inorganic chemicals with the potential to react with synthetic and clay liner materials (EPA 1983).

II.2.3 Factors Contributing to Success

The two main elements of success are considered to be: 1) a proper engineering approach, and 2) the extensive use of quality assurance programs throughout all phases of facility construction and operation (Arthur D. Little, Inc., 1985b). Those responsible for the facility must therefore understand the importance and complexity of the undertaking. A successful approach is to assume there will be problems and take appropriate steps to avoid or minimize the consequences.

Other factors that have been found to contribute to successful construction and operation of land disposal facilities include: 1) overdesign of the system; 2) building to specifications; 3) selection of qualified engineers and contractors; 4) cooperation among companies performing the work; 5) conducting waste-liner compatibility tests; 6) simplicity of design; and 8) good weather (Arthur D. Little, Inc., 1985b).

II.3 STATE-OF-THE-ART

II.3.1 General

The state-of-the-art in land disposal facilities has evolved over time through assessment of past practices and results, the introduction of new materials and concepts, and efforts generally directed at solving specific problems that have occurred at various sites. Past practices resulting in problems have encouraged the study and solution of the individual modes of failure. The following sections discuss state-of-the-art techniques, materials, and concepts.

II.3.2 Quality Control

The quality control aspects of liner installation and landfill construction are critical to the success of any land disposal facility. The degree of waste containment is only as good as the technology installed. The critical nature of installation quality dictates that a qualified team of quality control personnel monitor all aspects of construction. This requires a comprehensive inspection and audit program to ensure attainment of design specifications. Proper installation of synthetic and clay liners, as well as

all other systems within a hazardous waste land disposal facility, requires strict adherence to detailed installation procedures to achieve facility performance specifications.

II.3.3 Foundation

The foundation for any type of liner system, from synthetic to soil or clay, requires a firm and unyielding base. A properly constructed foundation reduces the possibility of failures due to puncture, tear, creep, and differential settling.

Foundation design requires appropriate site exploration and testing including evaluation of the regional geology, foundation soil boring and sampling, and other site and laboratory investigations where necessary to evaluate subsurface conditions. The proper use of this information in foundation design will ensure that a waste cell foundation will not subside under the loads imposed during placement operations or over time once a cell is completed.

Subgrades and fill embankment slopes forming the base and sides of any waste cell require treatment similar to any engineered embankment structure. Subgrades composed of fill are constructed in a series of individually compacted layers or lifts to ensure uniform compaction. Thickness of lifts is evaluated based on the type of material being used, the compaction equipment, the required amount of compaction, moisture content, and final density required. Inspection and testing of engineered fills during construction of each of these attributes provides insurance against subsidence.

Excavated subgrades are generally compacted only at the surface. The regularity and texture of the surface layer in the compaction scheme is critical to liner installation, particularly synthetic liners. Rocks or other irregularities, particularly with sharp edges, should be eliminated prior to installation of a flexible membrane liner.

II.3.4 Liners

II.3.4.1 Waste Compatibility and Liner Materials

Numerous liner materials, both natural and synthetic, have been used for containment of wastes, with the selection based on several factors.

The most consistently important factor in liner selection is compatibility of liner and waste, since incompatibility implies the possibility of chemical reactions that can destroy the integrity of the natural or synthetic liner. Research has been conducted to test the reactivity of common hazardous waste materials with common liner materials, both natural and synthetic (Arthur D. Little, Inc., 1985a; EPA, 1978, 1983). Natural materials tested have included soils and clays. Synthetics tested have included chlorinated polyethylene, high density polyethylene, chlorosulfonated polyethylene, and polyvinyl chloride. Testing has been conducted through the use of numerous methods such as direct application of waste to natural and synthetic materials and the pouch test for synthetics to determine permeability.

Based on this research, liner selections can be made on a preliminary basis with respect to the waste to be contained. When highly concentrated wastes are to be contained, or if wastes are not well documented or previously studied, compatibility testing is required during design or predesign phases for appropriate liner selection.

Related subjects are waste-to-waste compatibility and the segregation of incompatible wastes. These arise when there are a number of different wastes are involved, such as at RMA. The wastes have the potential for generating reaction by-products incompatible with a specific liner, even though the original wastes may be compatible with the liner material, in addition to generation of heat and liberation of gases and liquids. Incompatible wastes, depending on concentration and volume, may, therefore, need to be segregated into separate waste cells or neutralized prior to placement.

II.3.4.2 Multiple Layers

Current hazardous waste land disposal practice requires the use of multiple

liner systems in combination with leachate collection systems (IT Corporation, 1984). Multiple liners provide a backup or redundant system in the event the first barrier is breached.

Multiple liner systems can consist of combinations of natural and synthetic liner layers or multiple synthetic liners. The most common system found in the literature review was a clay foundation liner overlain by one or more synthetic membrane liners.

The number of liners used in any given design is dependent on the relative hazard of the waste, the required containment design period, and applicable agency regulations.

II.3.4.3 Foundation Layer

The foundation layer of the waste cell bottom liner system is often made of clay. Clay foundation layers have ranged from approximately 2 to 25 feet in thickness. The thicker foundations are typically compacted clay on an existing clay surface. In multiple liner systems, the clay liner acts as a final barrier to contaminant migration in the event of a failure of the upper liner.

One of the desirable characteristics of clay as a final barrier is its ion exchange capability. Testing has shown that concentrations of hazardous materials in leachates percolating through clay materials will generally be reduced as a result of ion exchange. This is particularly true in the case of heavy metals. The cation exchange capacity varies from high to low in the order of montmorillonite, illite, and kaolinite. The exchange capacity has also been shown to be highly dependent on the pH of the leachate (EPA, 1978). Organic materials also react with components within the clay matrix and can reduce the hazardous component of the leachate. Heavy metal or organic ions become a part of the clay matrix replacing less hazardous or nonhazardous ions, which are released. A drawback is that excessive leachate can saturate the clay matrix over time with replacement ions and chemically break down the matrix, resulting in increased permeability and loss of further exchange capability.

Synthetic liners are also used as the foundation layer in multiple liner systems. Surface preparation requirements are more stringent for a synthetic foundation membrane compared to a compacted clay foundation. As described previously, the synthetic liner is prone to tear and puncture and, therefore, requires a greater degree of surface preparation to remove rocks and other irregularities in the subgrade surface.

Any synthetic membrane liner upon which construction equipment will operate requires a cover layer of 1 or 2 feet of material to protect it from puncture or tears during construction and operation of the waste cell.

II.3.4.4 Cover Laver

A well engineered and constructed waste cell cover provides the initial barrier to contaminant and leachate migration by reducing water infiltration and subsequent leachate production and percolation through contaminated materials.

As with the bottom liner system, covers are generally multiple-liner systems using natural and synthetic materials in various combinations. Current standards stress the importance of the cover system by requiring permeability rates less than or equal to the bottom liner system. Cover systems typically include a buffer or gas collection layer directly above the waste material, a filter layer of either sandy material or filter fabric, one or more barrier layers consisting of clays or synthetic membranes, a drainage layer, a loam or topsoil layer, and a vegetated or armored cover layer (EPA, 1982).

Specific factors or considerations relating to the cover system include materials selection, water storage capacity of soils, evapotranspiration rates, freeze-thaw cycles, rainfall, vegetative cover, surface and subgrade drainage, surface slopes, and wind and water erosion potential.

Rainfall intensity during normal precipitation or storm periods influences the surface slope selected to promote groundwater runoff while avoiding erosion of the surface soils. Slopes as low as 5 percent have been suggested; however,

the general practice is a maximum slope of 4:1 (EPA, 1982). Some reduction in rumoff unavoidably occurs through infiltration into the cover soil, the amount depending on the nature of the surface and the soil's capacity to hold or transmit water. Evapotranspiration releases soil moisture in to the atmosphere and reduces net infiltration. Infiltrated water penetrating to the bottom of the soil layer encounters a drainage layer above the uppermost barrier.

The depth of the loam or soil cover layer required is that which will prevent freezing and thawing of the more sensitive components of the cover system.

The sensitive components include the clay or synthetic membrane barrier layers.

Wind erosion is reduced by appropriate side slope selection, orientation of the waste cell, and the final cover. The final cover may be armor rock or vegetation, depending on circumstances such as climate and desired maintenance effort.

II.3.5 Leachate Collection and Treatment

Waste cells are provided with leachate detection, collection, and treatment systems. These systems provide detection of primary liner failure, prevent a buildup of hydraulic head on liners from liquid infiltration, and remove excess liquids from the cells in a controlled manner.

The leachate collection systems control leachate migration, the major mechanism of contaminant migration outside the cell. Collection systems are designed to provide gravity drainage and adequate discharge capacity at low hydrostatic heads.

The systems generally include a layer of porous material to collect the liquids and a series of lateral pipes that transport the liquid within the cell to a main discharge pipe from which it flows outside the waste cell to a storage or treatment unit. Geotextiles are sometimes incorporated into the design to prevent migration of the porous material into the pipe system.

Design considerations to prevent failure of leachate collection systems include pipe location, redundancy, and maintenance features. Pipe location and placement are critical to avoid crushing or displacement by equipment loading and differential settling (EPA, 1985). A pipe is best protected when it is placed in a trench, with careful consideration given to loading conditions and proper bedding to provide protection for the pipe, especially during placement of the first lift of waste when the pipe is most susceptible to crushing.

Redundancy in design is important to minimize the effect of individual failures. The system should be able to remove liquid from any point in the facility by more than one pathway (EPA, 1985). One of the primary ways to provide redundancy is to design collection laterals to allow drainage by the porous layer alone if flow through a lateral is restricted. In addition, laterals should be spaced so liquid can be removed through an adjacent lateral if one lateral is completely blocked.

Leachate collection systems can be designed to avoid specific clogging mechanisms. For example, sedimentation can be avoided by selecting the proper grain size distribution for the filter material, incorporating geotextiles into the design, and providing minimum slope to maintain flow velocity so that solids cannot settle out. Maintaining flow velocity will prevent buildup of biological and chemical materials. Proper selection of construction materials based on the wastes to be handled avoids deterioration caused by reactions with waste leachates.

Leachate collection system construction according to design specifications is critical. Construction quality assurance (CQA) is necessary to verify that the completed leachate collection system meets or exceeds the design requirements. This involves monitoring and documenting the quality of materials used and the conditions and manner of their placement (EPA, 1985).

Another important consideration to prevent failure is designing the system to facilitate inspection and maintenance. Cleaning and inspection access should

be provided to all parts of the system. This includes the placement of manholes and cleanouts so that maintenance equipment can reach any section of pipe. The design should consider minimum pipe size, distance between access points, and maximum angles negotiable by maintenance equipment. Regular inspections include monitoring flow at outlets or access points, monitoring leachate level within the facility, correlating leachate quantity with rainfall data, and correlating leachate quality with clogging indicators, such as the presence of iron-reducing bacteria. These periodic inspections will allow the detection of any problems that require corrective measures.

The final requirement of state-of-the-art leachate collection systems is an ongoing maintenance program. Although maintenance and repair often involve the same methods, regular maintenance may be the more cost-effective option.

II.3.6 Gas Collection

Gas collection systems are installed to vent the landfill to prevent pressure buildup, fire, explosion, or off-site migration of gases produced in the wastes. Chemically hazardous gases are discharged within applicable air quality standards or treated prior to discharge to meet the standards.

The collection and venting systems are composed of a layer of coarse graded sands or gravel placed directly on the surface of the waste material as the initial layer of the cover system and associated vent piping or of vent piping alone, located at local high points. Gases generated are collected and discharged to the atmosphere or to a treatment facility through vents at regular intervals.

II.3.7 Run-on and Runoff Control

Run-on control is provided by maintaining ground contours that slope away from the cells to prevent water from traveling toward the cells. Run-on control prevents runoff from surrounding areas entering an active waste cell or passing over a closed cell. Leachate caused by rainfall within an active waste cell boundary is collected in a sump or through the leachate collection system. The collected runoff or leachate is then treated or transported

off-site for treatment.

Rumoff control is provided by cell grading and drainage to dissipate rainfall rumoff on the cell cover so that flow concentration and consequent erosion of soil covers and abrasion of liner materials are avoided. Ground cover, such as grass, reduces the overall amount of potential rumoff. Rumoff from the surface of completed cells will be collected by the surface water control system, which may consist of drains, gutters, collection and transmission piping, and ditches.

II.3.8 Monitoring System

In addition to secondary leachate detection systems within the waste cells, monitoring wells are typically placed around the waste cells. The wells provide samples for determination of baseline groundwater conditions prior to waste placement, for comparison to later conditions, and upgradient conditions, for comparison with downgradient conditions, after waste placement. The monitoring wells provide a final detection system for contaminant migration from the waste cells as well as migration of contaminants toward the waste cells from other sources.

II.4 REVIEW OF PREVIOUS CONCEPT DESIGN

A concept design was prepared for a hazardous waste land disposal facility located on RMA to contain wastes from the Basin F closure (IT Corporation, 1984). The conceptual design of the waste cells proposed in the report was state-of-the-art based on RCRA requirements and guidelines. The stated objectives of the concept were to eliminate leachate and provide the maximum possible protection to the environment.

The facility concept design involved earthen waste cells with multiple liners for both the foundation and cover layers, a leachate control system, a surface water run-on and runoff control system, monitoring wells, a gas collection and venting system, and support facilities. Six cells were designed, each with a waste capacity of 100,000 cubic yards, for disposing of 600,000 cubic yards of solidified Basin F wastes. Each cell would be constructed within a covered

building for weather protection of the working area.

During the concept design study, three waste cell types were evaluated, including an earthen cell, a reinforced concrete cell, and a slurry trench cell. An earthen waste cell was selected because it could utilize the lowest permeability liners, would be flexible with regard to location, and could be constructed with common earthmoving equipment and procedures. Three liner types were evaluated for use in the top and bottom liner systems: clay, synthetic membrane, and soil cement. Consideration was given to permeability, leachate compatibility, long— and short—term integrity, constructibility, and economics. The clay and synthetic liners were considered suitable for the waste cell concept. The soil—cement liner was judged unsuitable because of a higher permeability, greater cost, and unproven technology for use in hazardous waste disposal facilities.

The selected bottom liner system included three liners: a double layer of 100 mil HDPE (high density polyethylene) synthetic liner and a single 2 foot thick compacted clay liner. The synthetic liner was considered the more suitable for the upper layers of the bottom liner system because it is more resistant to concentrated leachate. The clay liner was considered more suitable for the lower layer of the liner system because clays are known to have a better long-term life than synthetics, are naturally self-sealing, and will maintain a low permeability indefinitely unless the chemical composition is severely altered through chemical interactions. The compatibility of the clay minerals in a clay liner with any potential leachate from the waste would be evaluated during final design. Synthetics were stated to have a greater potential to deteriorate with time, based on current evidence, and field seams were considered to be long-term weak points. The useful life of synthetics was determined to be not well known because of their relatively recent introduction and corresponding lack of long-term case histories.

The conceptual design located the leachate collection and detection layers above and between the two synthetic liners. Above the uppermost synthetic liner in the foundation liner system, a series of collection pipes were

located to drain any leachate to a collection sump. The base of the cell was sloped at a 4 percent grade to drain the leachate to the sump by gravity. Between the two synthetic liners a granular or porous fill and associated piping a leachate detection layer. The leachate control system also included a compacted clay bulkhead along the perimeter for additional protection against leakage and an at-grade steel collection tank underlain by an HDPE liner. Any leachate generated would be drained by gravity from the waste cells to the tank.

The cover system consisted of a triple-lined system with a permeability equal to or lower than the foundation liner/leachate collection system. The cover system included two 100 mil HDPE synthetic liners and a single 2 foot thick compacted clay liner. In addition, the cover system contained a vented gas collection layer, drainage layer, and a soil cap.

II.5 REVIEW OF RADIOACTIVE WASTE FACILITIES DESIGNS

Current designs for hazardous waste land disposal facilities have evolved in parallel with development of the disposal technologies used for solid waste and radioactive waste. Low-level radioactive waste disposal technology in the U.S. began with shallow land burial in trenches at 12 sites. Five of these trenches have failed, leading to the development of significant public resistance to the practice. Subsequent developments included the exploration of effective capping techniques and the study of substantial containment structures such as concrete vaults. Most actual experience with vault structures is at facilities in Canada and France. The most advanced commercially available technology employed in the U.S. at present is concrete canister disposal.

The French facility at La Manche uses two superimposed systems. High activity waste is embedded in concrete monoliths in a shallow trench (below ground), while low activity waste is placed on top of the monoliths (above ground) in earthen mounds. This facility uses a significant amount of concrete and has a dedicated cement plant on site.

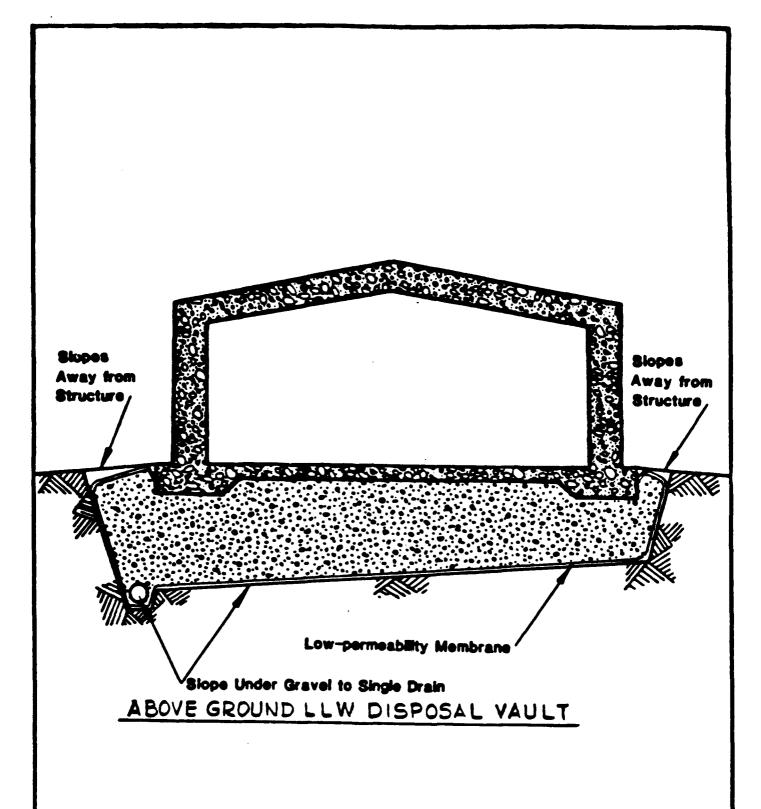
The USAEWES prepared a series of reports for the U.S. Nuclear Regulatory Commission (USAEWES, 1985). The report outlined requirements for above-ground and below-ground vault disposal of low-level radioactive wastes. Figures II-1 and II-2 show sketches of these two designs. The above-ground vault was considered to be an unattractive design for the following reasons: 1) since containment concrete is exposed, it is subjected to weathering; and 2) the design limits post-closure land use. For these reasons the below-ground vault was felt to be a superior design.

A below-ground vault similar in design to Figure II-2 is currently under construction at the DOE Hanford site. The vault is 125 ft long by 50 ft wide by 34 ft high. The vault walls are designed similar to a retaining wall and vary in thickness from 1 ft at ground level to 3-1/3 ft at the vault floor. The vault is equipped with both leachate detection and collection layers.

State-of-the-art hazardous waste land disposal facilities face similar requirements as state-of-the-art radioactive waste designs except that they must be larger in capacity. Typically, the quantity of radioactive waste placed in vaults is limited by the amount of radioactive material that can be safely placed together and by demands for a high level of radiation protection at the surface of the site. Hazardous waste, on the other hand, does not have the same quantity constraints. Designs for hazardous waste land disposal facilities may incorporate the containment features proposed for nuclear wastes with the economy of scale found in municipal solid waste facilities.

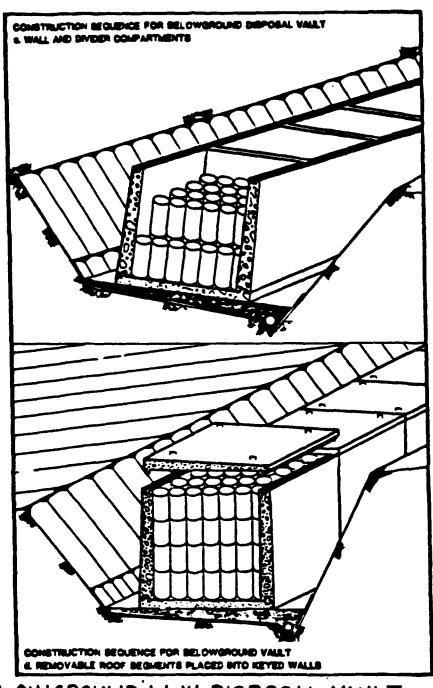
11.6 EXISTING LAND DISPOSAL FACILITIES DESCRIPTIONS

The design and permit documents for two recent state-of-the-art hazardous waste facilities have been reviewed with particular attention to how their designs relate to RMA conditions and requirements.



SOURCE: ALTERNATIVE METHODS FOR DISPOSAL OF LOW LEVEL RADIOACTIVE WASTES (NUREG/CR-3774 VOL. 2)

EBASCO RMA TASK 27 FIGURE II - I



BELOWGROUND LLW DISPOSAL VAULT

SOURCE : ALTERNATIVE METHODS FOR DISPOSAL OF LOW LEVEL RADIOACTIVE WASTES (NUREG/CR - 3774 VOL. 2)

EBASCO

RMA TASK 27 FIGURE II-2

II.6.1 Last Chance

On February 27, 1987, the Colorado Department of Health issued a hazardous waste permit to the Highway 36 Land Development Company, a unit of Browning-Ferris Industries (BFI), for a facility located near the town of Last Chance, Adams County, Colorado. The EⁿA RCRA permit was issued on March 2, 1987, following issue of the state permit. This facility was designed to store permitted hazardous waste in 16 secure landfill cells, each with a capacity of 158,000 cubic yards (total capacity of 2.5 million cubic yards). The facility was of great interest because it embodied the latest design and operating requirements and was located in Colorado at a location near RMA.

Wastes that cannot be disposed at Last Chance under the permits include the list of dioxins and organic solvents banned or limited in concentration by EPA under the revised regulations (40 CFR 268, effective November 8, 1986). Metals concentrations in waste are limited under the state permit. A comparison of the permit restrictions with the constituents of RMA wastes is provided in Table II-1.

The Last Chance site enjoys the same climatic advantages of the semi-arid high plains as RMA. It has an apparent geological advantage over RMA in that it lies over a thick bed of Pierre shale, a bedrock formation strongly promoted for hazardous waste facility siting by the Colorado Geological Survey, and an apparent hydrological advantage in that the regional groundwater table lies more than 100 feet below ground surface. However, both of these apparent advantages have been determined to be flawed upon detailed site study by the U.S. Geological Survey (Banta, 1986). The upper part of the Pierre shale is weathered and there are sandy zones, which could allow much greater hydraulic conductivity for leachate escaping the facility than unweathered Pierre shale; and there are perched water tables in the sandy zones that supply shallow wells in the area. These site defects have been mitigated by requirements imposed in the state permit for engineered barriers and monitoring, specifically the excavation of any sandy zones uncovered in the construction

LAST CHANCE PERMIT CONDITIONS
VERSUS CONSTITUENTS IN RMA WASTES

TABLE II-1

Constituent Present at RMA	Permit	Concentration Limit	Basin F Soils	Buried Sludge
Possible Exclusion				
Ethyl Benzene	Federal	0.05	1-8 (2 hits in 40)	
Toluene	Federal	0.33	1-1,000 (7 hits in 40)	
Xy1ene	Federal	0.15	10 (1 hit in 40)	
Acceptable				
Carson Tetrachloride	Federal	0.98	ok	ok
Chlorobenzene	Federal	0.05	ok	ok
Methylene Chloride	Federa1	0.96	ok	ok
Methyl Isobutylketone	Federal	0.33	ok	ok
Tetrachloroethylene	Federal	0.05	ok	ok
Arsenic	State	500	9.6	3
Cadmium	State	100	2	1.1
Chromium	State	500	19	5.7
Lead	State	500	24	26
le rcury	State	20	0.08	0.7

to a distance of 100 feet and replacement with low conductivity soil, and the installation of a large number of observation wells in sandy zones.

The design of the waste cells is a below grade, multiple-lined pit configuration. Bottom liners are one 80-mil HDPE flexible membrane and a 3 foot of clay. The cap is the same except the clay thickness is 4.5 feet (according to the state permit). The state permit requires the cover to include a drainage layer. Rodent protection consists of trapping and damage repair. Leachate removal is by pumping from sumps at the low point of each cell.

II.6.2 Grassy Mountain

The Grassy Mountain facility of U.S. Pollution Control, Inc., is located near Knolls, Utah, about 75 miles west of Salt Lake City between the shore of the Great Salt Lake and the Bonneville Salt Flats. The climate is arid to semi-arid, with about 5 inches of rain annually on average. Topographically the site is flat.

The facility is being expanded through addition of a new waste cell No. 3. The new cell is constructed on grade abutting two existing cells through construction of an earthen berm with 3:1 side slopes to a height of about 20 feet. Subsoils consist of various interlayered mixtures of clay, silt, and sand, with groundwater found at 8 to 19 feet below existing grade. Cell plan dimensions, inside crest to inside crest of the berms, are 710 by 752 feet. The bottom surface slopes 2.5 percent from the center toward leachate sumps at the perimeter; the final cover slopes 5 percent towards perimeter ditches.

The bottom liner system, which runs up the inside faces of the berms to their tops, is 7 feet thick and consists of 3 feet of clay at the bottom, overlain by a leak detection system; a primary 60 mil HDPE flexible membrane liner (FML) with a leachate removal drainage net and geotextile above it; 2 feet of soil cover; a tertiary 80 mil HDPE FML, again with leachate removal drainage net and geotextile above it; and 2 more feet of soil cover. The waste is placed on top. The leachate removal and leachate detection systems are

monitored and evacuated by pumping through inclined pipes that penetrate the liner system. The cap and final cover system consist of 2 feet of clay, 80 mil NDPE FML overlain by cover drainage consisting of geomet and geotextile, two feet of final cover soil, and 4 inches of "armor plate" gravel on the surface.

The permeability of remolded native clay found at the site varies from 2×10^{-8} cm/sec at moisture content 6 percent above optimum to 1×10^{-6} cm/sec for moisture content 2 percent below optimum. In the construction of the older cells and new cell No. 3, the native clay was modified by addition of 3 pounds of sodium hexametaphosphate per 50 cubic feet of clay as a deflocculating agent to achieve in-place liner permeabilities of less than 1×10^{-7} cm/sec.

II.6.3 Descriptions of Licensed Facilities

Table II-2 provides descriptive data regarding a number of licensed hazardous waste land disposal facilities in the U.S. The data include the location, the operator, the cell dimensions and construction materials, and site data where available. It can be seen that there is a wide range of sizes, shapes, and materials used in the waste cells.

TABLE 11-2

HAZARDOUS WASTE LAND DISPOSAL PACILITIES IN THE U.S.

		Cell	Cell Configuration	ration		Composition	Leachate		Location
Predominant Site Location Owner/Operator	Status	Plan Dimensions	Height Depth	Depth	of Top/ Bottom Liners	Collection/ Detection	Method of Construction	of Water Table	Foundation Soil
Casmalia, CA Casmalia Disposal Company	Operating	20 acress	0'-0" Above Grade	50°-0° Below Grade	60 mil HDPE 3'-6" clay, eand, and gravel	Primary and secondary liner with leachate collection and detection	Working Pace method with multiple layers	Mearest aquifer is 300' from site	Unveathered
Emmelle, Aleska Chemical Waste Management	Operat ing	,006 x ,006	0'-0" Above Grade	100'-0" Below Grade	Approx. 9'-12' thick double liner with 2-60 mil HDPE	Primary and secondary liner with leachate collection and detection	Working Pace method and and modular 4 modules per cell	600'-900' Matural Below Chalk Grade Deposit	Matural Chalk Deposit
Lake Charles, LA Chemical Waste Management	Operating	1	31'-6" Above Grade	40'-0" Below Grade	Approx. 9'-6* thick double liner	Primary and secondary liner with leachate collection and detection	Working Pace method and modular	At Grade	
Grand View, Idaho Envirosafe Services of Idaho	Idaho Operating Idaho	1,000'- 2,000' long; 250' wide	0'-0" Above Grade	40'-50' Below Grade	MDPE Netting 12° coarse sand between layers	Primary and secondary liner With leachate collection and detection	Tier method 3 with 3 lifts/ B tier; 3° soil G between lifts 1° fill between tiers	3,081' Belov Grade	Brown and blue clay with some shale
Bruno, Idaho Envirosafe Services of Idaho	Operating	500' x 500'	0'-0" Above Grade	60'-70' Below Grade	ŀ	1	ŀ	İ	Rock
Beatty, Nevada US Ecology	Operating	500' x 500'	0'-0" Above Grade	50'-0" Below Grade	Approx. 6' thick top liner, 150' thick natural clay bottom liner	k None er	!	300° Below Grade	Clay

Other Information

- 3 percent slopes or final cover.
 - Evaporation ponds for runoff.
- Mounded at the top for drainage.
- Cell No. 14 is under construction and - Cell No. 5 is topped off. has 3 modules.
 - Cell No. 6 will be constructed later and will consist of 4-6 modules. 11.5' levee surrounds the site.
- Liner is a mix of bentonite and clay with a permeability of 2x10-9.
 Site elevation is 2,900°.
 3:1 inside slope.
- Site is primarily rock which makes it too expensive to continue operating. - Hounded for drainage.

- Mounded for drainage.
 Site is located on 80 acres of land.
 New cell under construction to be larger and above grade.

TABLE II-2 (Continued)

HAZARDOUS WASTE LAND DISPOSAL PACILITIES IN THE U.S.

Site Location		Cell Configuration	iguration	•	Composition of Top/	Leachate Collection/	Hethod of	Location of Water	Prodominant Poundation
Owner/Operator	Status	Plan Dimensions	Height	Depth	Bottom Liners	Detection	Construction	Table	8011
Robstown, Texas US Ecology	Operating	200' x 300'	00. Above Grade	25'-30' Below Grade	Double synthetic liners top and bottom 3° clay, 18° soil	Primary and secondary liner with leachate collection and detection	l	1	1
Grassy Mountain, Utah U.S. Pollution Control, Inc.	Operating	710' x 752'	40'-0" Above Grade	00. Below Grade	7 thick liners 2-60 mil and 1-80 mil HDPB, 3 clay, 2 soil layers	Primary and secondary liner with leachate collection and detection	I	10' Below Grade	Clay and silty sand
Louisiana BF/CECOS International	Operating	650' x 375'	25'-0" Above Grade	50'-0" Below Grade	1	1	ŀ	1	ļ
Kettleman City, California Chemical Waste Management	Operating	36 acres square shape internal B	. 06	. 09	2 synthetic, 2 clay 60 mil HDPB 3' clay	Standard multiple collection/ detection system	Layered with internal cells	\$00. deep	Sandetone, claystone
Benecia Disposal Pacility, CA IT Environmental Corporation	Undergoing Closure	Consi	tructing a	state-of-a	Constructing state-of-art cells in vicinity of cells undergoing closure.	y of cells undergoi	ng closure.		
Mawkins Point Disposal Site No. 2, Annapolis, Maryland Maryland Environmental Service	Construc- tion	;	. 0	ł	80 mil HDPE, 2.0° clay, 60 mil HDPE on bottom	Multiple	ł	10 - 20	Per meab i e
Sion, Illinois Browning Perris Industries of Illinois	Operating	S acres	20.	, 09	Bottom-10' clay and 2 synthetics. Composit cap.	Multiple	!	10-15 Below Grade	1

Other Information

- Nounded for drainage. Site is located on 240 acres of land.
- 3:1 inside slope. All external slopes have gravel armor protection.
- Maximum waste thickness is 65 feet. Designing a cell which is 1,700' x
- No significant potential groundwater problems. Cap-1.5' earth, 1.5' clay (10-7), 60 HDPE, drainage layer, earth, vegetation.
- Not commercial, will be used in cleamup of chrome ore tailings.
- 10° clay is Illinois State requirement.

TABLE II-2 (Continued)

HAZARDOUS WASTE LAND DISPOSAL PACILITIES IN THE U.S.

Site Location		Cell Configuration	lguration		Composition of Top/	Leachate Collection/	Nethod of	Location of Water	Predominant Poundation
Owner/Operator	Status	Plan Dimensions	Height	Depth	Bottom Liners	Detection	Construction	Table	8 011
Arizona (Phoenix area) EMSCO, Inc.	Permitting/ Construc- tion	1	1	300.	Double synthetic with recompacted clay foundation (10 ⁻⁵ -10 ⁻⁷)	Multiple	Horizontal due to depth	400' below grade	ı
Texas City, Texas Gulf Coast Waste Disposal Authority	Operating	250' x 800'	20.	15.	3° clay, 60 mil HDPE, 2° clay, 60 mil HDPE	Multiple, gravity Continuous trench	Continuous trench	Delow clay 260' layer Beau (260') clay	260 * Beaumont clay
Arlington, Oregon Chem-Securities Systems Inc.	Operating	;	į	i	2-3' clay layers 2 synthetic	Collection and detection systems	i	200' below grade	Rock
Bruno, Idaho Envirosafe Services of Idaho	Operating	500' x 500'	At grade 60-70' mounded	. 00-10	:	i	:	ł	Rock
Lest Chance, Colorado CECOS International/ Browning Perris	Permitted	150° ж 630°	1	35,	3° clay with multiple 80 mil HDPE synthetic liners	Primary collection system and detection system		ŀ	Shele

Other Information

- Neap leaching technology. Contract with state to build and operate.
- 3:1 slopes clay, synthetic, and soil
 - cap.
 Stacked cells, cape form base of second layer of cells.
- Impermeable rock foundation.
- Closing in near future.

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APPENDIX III

OPERATIONAL PLAN AND SCHEDULE

III.0 OPERATIONAL PLAN AND SCHEDULE

III.1 GENERAL

Development of the land disposal facility will occur in three phases, including site development, operations, and closure. The site development plan includes all the work necessary before the receipt of the first load of RMA contaminated materials. The operating plan explains operations of the facility during waste placement in compliance with hazardous waste regulations. The site will be restored, monitored, and cared for after site closure according to the closure and postclosure care plan. These plans will ensure compliance with regulations to provide long-term isolation of the RMA contaminated materials.

III.2 SITE DEVELOPMENT PLAN

Site preparation, buildings, utilities, environmental protection facilities, and initial waste cell construction must be completed before the first cubic yard of RMA contaminated materials can be placed in the waste cell. Table III-l outlines the general sequence of tasks for site preparation and initial waste cell construction. After the first wastes are placed in the first waste cell, the site development is complete. The first waste cell is typically built at the lowest elevation on the site, closest to the runoff control pond and leachate evaporation pond. Upon completion of the work under the site development plan, the operating and closure plans will begin concurrently to minimize the exposed working face and protect waste and cell surfaces from wind and water erosion.

III.2.1 Site Preparation

To prepare the disposal site for waste placement, the site soil and topography must be examined to develop detailed final designs from site survey information. Groundwater monitoring wells will be installed to determine background groundwater quality up— and downgradient to the site. This will provide the means to monitor the regulatory compliance of the waste cells.

TABLE III-1

GENERAL TASKS FOR SITE PREPARATION AND INITIAL WASTE CELL CONSTRUCTION (Clean or Support Zone Construction)

- 1. Monitoring station and wells construction
- 2. Soil and groundwater background sampling
- 3. Initial road construction and site survey
- 4. Clear and grade site
- 5. Construct berms
- 6. Install drainage improvements
- 7. Remove and stockpile topsoil
- 8. Stockpile clean soil materials for leachate drainage and gas venting, clean final surface
- 9. Install environmental protection facilities
 - a. Leachate treatment and transmission piping from leak detection system
 - b. Gas monitoring wells and equipment (optional)
 - c. Decontamination facilities
 - d. Sanitary sewage and treatment
- 10. Construct support facilities
 - a. Service buildings
 - b. Employees' facilities
 - c. Fueling facilities
 - d. Administration, laboratory, and scales facilities
- 11. Prepare access roads
- 12. Install utilities
 - a. Electricity
 - b. Water
 - c. Sewage
 - d. Telephone
- 13. Initial bottom liner installation in waste cell
- 14. Initial leachate collection system construction in waste cell
- 15. Construct fencing
- 16. Quality assurance/quality control slope and subgrade preparation, bottom liner installation, leachate collection installation, and groundwater and soil sampling and analysis
- 17. Clean construction health and safety requirements

Reference: 0'Leary (1986).

With the development of final engineering plans, initial road construction and site clearing and grading can begin. This will involve stripping the top 4 feet of soil. The topsoil will be removed and stockpiled for site restoration. Additional clean, sandy soil will be stockpiled for use in constructing leachate drains and clean final cover grading. Other stripped soils will be used for berm construction.

III.2.2 Buildings and Utilities Construction

While site preparation is being completed, the construction support and environmental protection facilities will be installed. The support facilities include heavy equipment maintenance buildings, employee facilities (including decontamination areas), fueling facilities, administrative, laboratory, and truck scale facilities. These facilities will require access roads and connection for electricity, water, sewage, and telephone. The heavy equipment maintenance garage is shown in Figure 6-5 as a 15,000 square foot building. The employee facilities will include personnel decontamination and clean area equipment storage trailers. The laboratory will be a 400 square foot building for chemical and physical testing of contaminated materials and clean soils. The administration building will be 2,400 square feet in area, to house an employee lunchroom, equipment storage, truck scaling offices, and supervisory, administrative, health and safety, and QA/QC personnel offices. These facilities will support the heavy equipment and the 30 to 60 person construction operation, and may be scaled up or down depending on buildout period.

III.2.3 Environmental Protection Facilities

While the site grading and earthen berms are being completed, the drainage improvements will be constructed to control stormwater. These will include runoff ponds and drainage ditches. Other environmental protection facilities will include the leachate treatment pond (evaporation pond) and bottom liner leak detection system to the leachate treatment pond. During operation and postclosure care periods, contaminated runoff will be trucked and pumped into the leachate treatment pond. It is expected that leachate generation will be minimized by maintaining small working faces and practicing rapid placement of

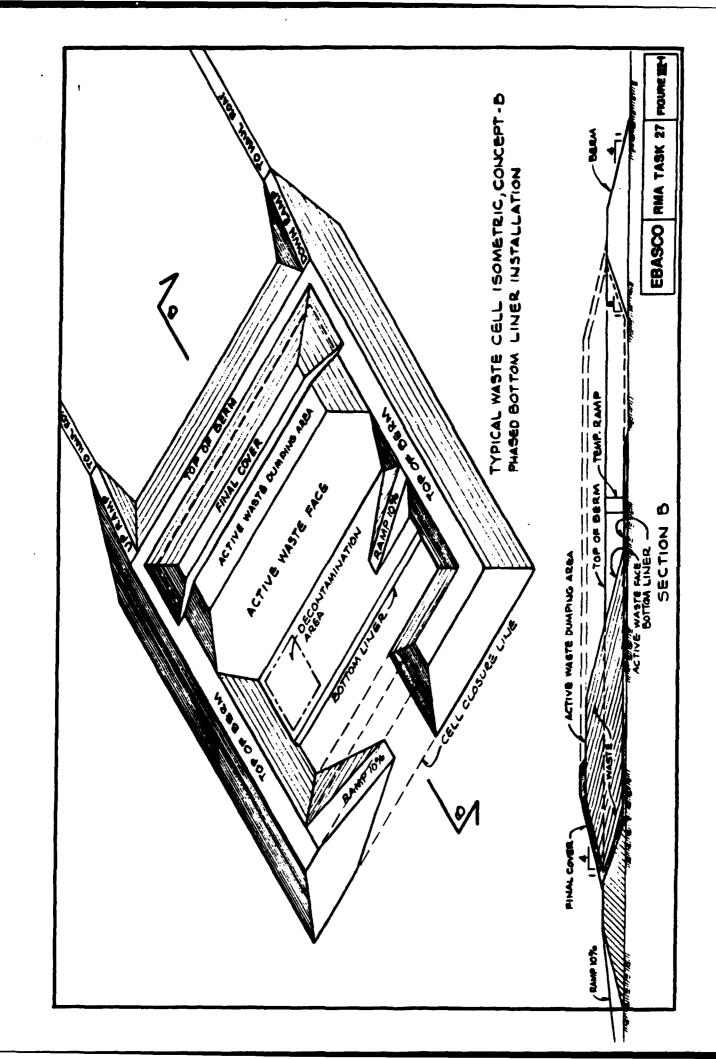
the cell cover upon reaching final grade. The leachate pond will be a CERCLA surface impoundment that will meet all pertinent ARARs.

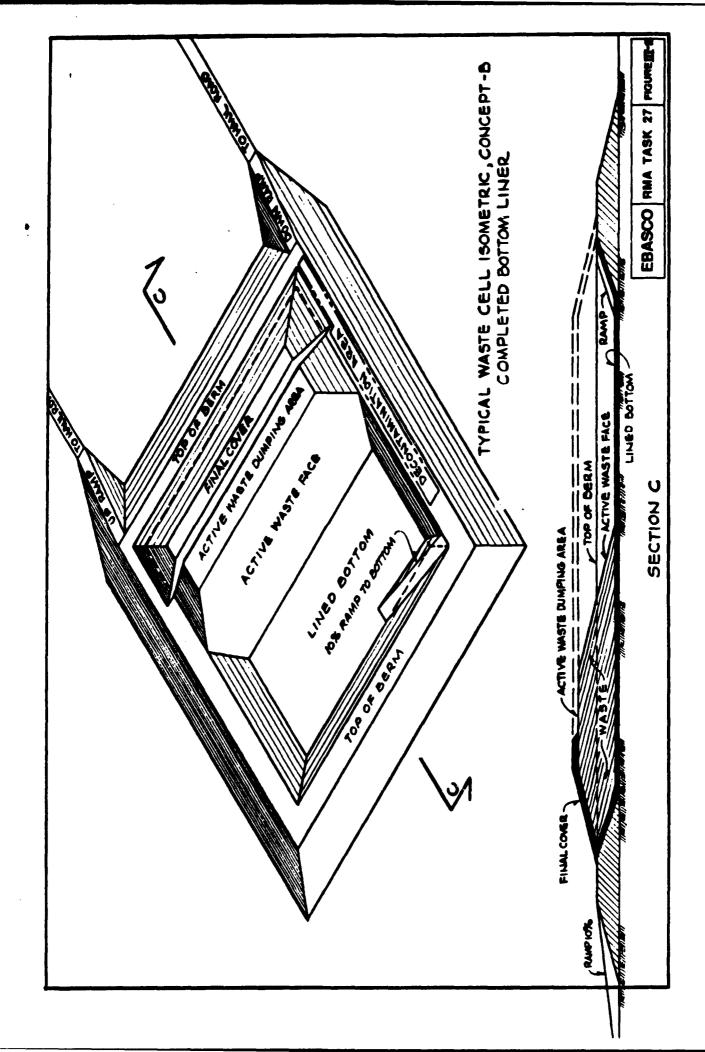
Heavy equipment decontamination water will be trucked to the leachate treatment pond from the mobile truck washing operation at the waste cell decontamination area. A permanent truck washing area near the maintenance area and gate entrance will be available as necessary to supplement the field decontamination operations. The leachate and rumoff ponds will be placed at the lowest points of the site to collect stormwater by gravity drainage and leachate by a pump and truck operation.

Preliminary air pollution modeling suggests that dust control is a primary concern for the haul roads rather than the site excavations or waste placement. Dust control will require clean water for roadways, which will be stored in water tanks near the front gate. Contaminated water will be drawn from the leachate pond or mobile decontamination facilities in the waste cell for dust control within the waste cell. The working face will be sprayed with this water along with dust suppression agents to minimize the release of contaminant dust during the dry season.

III.2.4 Waste Cell Construction

The earth berms will be constructed of clean subsoil, from uncontaminated areas, primarily stockpiled during the site grading operation, as the first step in waste cell construction. The berm will be placed in controlled lifts to compact the soil to specified density, probably a minimum 90 percent modified Proctor density. For the smaller waste cell (250,000 cy), the berms will be completed with a ramp into the cell before placement of the bottom liner, leachate collection system, and protective drainage layer, as shown in Figure III-1. Where larger waste cells are used, phased berm and bottom liner installation will be used as shown in Figure III-2.





The bottom liner installation will entail placement of a 3 foot soil-bentonite mixture (clay), a 1 foot drainage layer for leak detection, a 100 mil thick high density polyethylene (HDPE) flexible membrane liner, geomet and filter fabric, and 1 foot of sandy, lightly contaminated soil free from stones or sharp objects.

The clay will be placed in thin lifts (6 inches or less) at proper moisture content with proper heavy equipment for compaction. A tamp-foot or sheeps-foot roller will be used to break apart clay or soil lumps and knead the clay together to form a homogeneous layer. Visual control will be used to eliminate unacceptable materials. Density testing will be performed on each lift as the liner is placed. Construction techniques will be developed on test fills to establish lift thickness, number of passes, and moisture, based on testing of clay physical properties in field and laboratory. The clay layer thickness will be controlled by surveying to ensure a proper final surface slope. Hand compaction will be used around leak detection piping and leachate system sumps. The side slope liner will be installed in horizontal lifts parallel to the side slope.

The drainage layer (leak detection system) will be sandy materials placed over the clay liner surface to a carefully measured 1 foot depth. The side walls will be push up slope for placement. The grain size and permeability of the sandy materials, as placed, will be carefully controlled by field and laboratory testing to ensure that the required drainage characteristics are achieved. The same procedures will be followed later for the drainage layers in the cell cover.

The FML will cover the drainage layer. The liner material will be rolled onto the drainage layer with all field seams thermal-welded and tested for leaks. Particular care in installation will be taken at slope changes and sump construction.

No penetrations will be allowed in the bottom liner FML. The leachate collection system consisting of geonet; removal, lateral, and main line piping; and leachate sump will be placed on top of the FML. The geonet will be protected by filter fabric and 1 foot of sandy soil. The leachate removal, lateral, and main collection lines, and leachate sump will be protected by a sand drainage blanket as deep or deeper than the drainage layer. The leachate removal line will pierce the cover liners and rest on top of the bottom liner so that the bottom FML is not pierced by any leachate collection line, as shown on Figure 7-8. Depending on the availability of good quality sandy contaminated material, a clean or contaminated sand drainage layer will be extended over the bottom liner and leachate collection system for additional protection.

When the bottom liner and leachate collection system is installated, the work area will be a clean area so that hazardous waste health and safety issues will be minimized and efficient construction practices will be used. The placement of the first cubic yard of contaminated materials onto the bottom liner will create a contaminated area or contamination zone; safety requirements must be observed and decontamination facilities and a decontamination zone must surround the contaminated area. This will be done to prevent contaminated soil from reaching the support zone or clean area while waste cell construction is in progress.

III.2.5 Quality Assurance/Quality Control

Construction quality assurance/quality control (QA/QC) will be the critical element in site development and subsequent waste cell construction.

Construction QA/QC will involve a strong organizational commitment, a detailed construction quality assurance plan, and careful documentation.

Construction Quality Assurance Plan

The audit program or construction quality assurance (CQA) plan is the written approach followed by the owner/operator and his supporting organizations to attain and maintain high construction quality. While the overall content of the CQA plan will depend on the site-specific nature of the facility, at a minimum the plan should include: 1) areas of responsibility and lines of

authority in executing the CQA plan; 2) qualifications of personnel; 3) types of observations and tests to be performed; 4) design of a sampling plan, including sampling frequency, acceptance/rejection criteria, and corrective action procedures; and 5) documentation procedures and recordkeeping.

The inspection program of construction quality control (CQC) will consist of the active inspection of ongoing activities. These inspection will include:

1) on-site observations of the work in progress to assess compliance by the contractor with the plans, specifications, and construction-related contractual provisions for the project; 2) field and laboratory tests;

3) reports to the CQA officer of the results of all inspections, including work that is not within contractual quality or fails to meet contract requirements; 4) monitoring of reviews and tests conducted by the contractor as required by the construction specifications and contract; and 5) verifying that tests, equipment, and system startups are conducted by qualified personnel and proceed according to standardized procedures defined by contract documents.

The effectiveness and ultimate success of the hazardous waste land disposal facility will depend on the qualifications and performance of the personnel. The CQA officer should possess a degree in engineering, professional registration, and sufficient practical experience in land disposal facility construction and construction site experience to demonstrate expertise for the successful implementation of CQA-related activities. The inspectors should also have degrees in engineering and enough practical experience in construction inspection to be familiar with specific practices in the field relating to construction techniques, codes, and regulations regarding material and equipment installation, site safety, and testing. Technicians responsible for sampling and testing need only be qualified to perform those activities; however, no work should be allowed without the presence of an inspector qualified as described above.

The CQA plan will specify that after completing the various facility components, CQA/CQC personnel will conduct a final inspection, including

completion tests, to make certain that each component was installed according to design specifications.

Upon completion of the project, a final documentation report will be prepared and a copy retained in the facility operating record. This report will include summaries of all construction activities, observation and test data sheets, problem reporting and corrective measures data sheets, block evaluation reports, deviations from design and material specifications, and as-built drawings.

Documentation

Documentation in support of the CQA/CQC program will be carried out throughout the construction and post-construction period. Standard reporting procedures will include daily preparation of field data sheets. These data sheets will include such information as the date, weather conditions, construction operations in progress, the location and results of CQA/CQC tests conducted, description of any problems encountered, corrective actions, and the signatures of responsible personnel. A daily summary report will be used to provide the chronological framework for identifying all other reports.

Grain size analysis and compaction testing are important to control proper disposal site foundation construction and sub-base preparation. Much of this work will occur during site preparation. A sample grid will be prepared based on identification of different soil classifications encountered at the disposal site. The foundation soils will be compacted to 90 percent of the modified Proctor density or the in-place density of the surrounding soils.

Installation of the bottom liner and leachate systems will require documentation of the following parameters (Fowler, 1986).

Clay Liner

- o Density testing (including as placed moisture content)
 - 100 foot grid spacing per 1 foot thickness
 - Offset grid pattern in each lift
 - Greater testing frequency in confined area
- o Moisture density (Proctor) curves
 - Every 5,000 cy or less
 - Each major soil type
 - Five point curve
 - Modified Proctor density
- o Grain size analysis (including Atterburg Limit)
 - One test per acre or smaller area
 - Sieve to 200 mesh
 - Hydrometer beyond 200 mesh to 2 micron
- o Lab hydraulic conductivity
 - Performed on every third grain size sample
 - Undisturbed sample (Shelby tube)
 - Falling head
 - Optional use of contaminated groundwater to simulate leachate
- o Survey control
 - 100 foot grid
 - Preliner placement
 - Post-liner placement

Drainage Layer

- o Grain Size
 - One test per 1,000 cy material placed
 - Minimum four samples
 - Test to 200 mesh
- o Lab Permeability
 - One test per 2,500 cy of material placed
 - Remolded to in-place density
 - Permeability test with optional use of contaminated groundwater

Flexible Membrane Liner

- o Test seams (factory and field); one field test sample per acre or less
- o Leak test all continuous seams

Leachate Collection System

Bedding material one grain size per 1,000 linear feet of tranch, with a three-test minimum

- o Check invert elevations of pipes, sumps, and manholes
- o Check trench and line locations
 - Ensure that photographs are taken of anti-seep collars, manhole connections, and sump connections
- o Leak test manhole and leachate line to leachate pond
- o Clean out leachate lines

The preceding tests and documentation will be supplemented by photographic records and log books for each waste cell.

III.3 OPERATING PLAN

The general tasks for site operations and new waste cell construction are presented in Table 9-2. These tasks support ten work items for the operating plan as follows:

- o Waste Cell Construction This work item describes waste cell construction that continues after site development.
- o Waste Control The analyses of waste chemical and physical characteristics are done to inventory wastes, improve waste compaction, and separate incompatible wastes.
- o Waste Cell Operations The timing and methods from the waste excavation to placement of waste.
- o Equipment and Maintenance Requirements This item describes the heavy equipment and maintenance required to excavate load, haul, and place the contaminated materials and liner materials.
- o Personnel Requirements These are a function of the waste operations, QA/QC, health and safety, and training needs for the buildout period.

TABLE III-2

GENERAL TASKS FOR SITE OPERATIONS IN WASTE CELL AND CONSTRUCTION OF NEW WASTE CELLS

- 1. Repeat tasks 3 through 8, 13, 14, 16, and 17 from Table 9-1 for new waste cell construction.
- 2. Waste excavation and transportation
 - a. Load and cover truck
 - b. Decontamination of truck
 - c. Transport to waste cell working face
- 3. Waste control inventory and sampling
- 4. Waste placement
 - a. Unload truck at waste cell working face
 - b. Spread onto fill and compact
 - c. Map position in cell of all waste placed to document waste control
- 5. Haul truck and waste cell personnel decontamination on leaving active waste cell area
- 6. On reaching final grade for waste, clean drainage layer installation
- 7. Initial cover installation and drainage modification
- 8. Initial waste cell site restoration
- 9. Leachate removal, transport, and disposal
- 10. Stormwater management system operation
- 11. Site monitoring
 - a. Leak detection
 - b. Groundwater and gas monitoring wells
 - c. Leachate sumps
 - d. Stormwater
- 12. Quality assurance/quality control slope completion, cover installation, waste placement and compaction, and groundwater and soil sampling
- 13. Health and safety waste excavation, transport, placement, and personnel monitoring for contaminated areas operations

Reference: 0'Leary (1986).

- o Environmental Controls These are applied to stormwater, leachate, gas and dust, and noise.
- o Site Monitoring This involves primarily monitoring environmental control activities and inspection of site construction.
- o Emergency Response This provides for the contingencies associated with unexpected events such as a fire, explosion, or liner failure.

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Quality Assurance/Quality Control - The QA/QC procedures control the successful installation of waste cells to ensure waste containment.

o Health and Safety - These aspects include use of the proper personnel, correct protective equipment selection and use, and the work flow from the support zone (clean area) to decontamination and contamination zones for waste placement.

III.3.1 Waste Cell Construction

The waste cell construction will be divided into three parts. The first will be the continuation of construction of the bottom liner and leachate collection system for new waste cells. The next part will be the waste operations and fill progression from initial waste placement to final grade, as shown in Figure III-1. The third part will be the cover system placement that closes up the waste cell.

The bottom liner and leachate collection system construction are described in Section 9.2.4. This activity is ahead of waste placement so that liner material can be placed in a clean area or support zone. Two basic bottom liner and leachate collection systems construction approaches could be used, the phased approach or complete installation approach.

During phased waste cell construction, the bottom liner and leachate collection system will be placed from the lowest to the highest ends of the

waste cell. These systems will be connected in phases so that the waste cells can be completed in more than one construction season if necessary. This approach will leave a minimum exposed working area. The placement sequence will ensure that contaminated runoff will always be contained during the phased construction of the waste cell bottom liner.

With a complete bottom liner and leachate collection system installation, there will be more exposed area for leachate production because the fully installed bottom liner system acts like a bathtub. However, the smaller waste cell sizes (less than 1 million cy) may be best installed as one unit because of the small exposed working faces and to minimize traffic and equipment congestion.

Easte placement will begin with as small a working face as possible in order to control waste compaction. The wastes are primarily soils that can expand as much as 15 percent after excavation. The soils will be compacted to reduce post-closure subsidence and associated settling problems with the cover.

The working face will become a contaminated area or contamination zone. A decontamination zone will surround the contamination zone so that personnel and equipment can be decontaminated before leaving the working face for the clean areas.

When the final grade for waste placement is reached, a clean drainage layer will be placed above the waste before final cover installation begins. This layer will drain contaminated runoff from the top of the fill to the leachate collection system during construction of the waste cell.

The final cover will be placed as rapidly as possible to reduce the area for contaminated runoff production in the active waste cell. The cover installation will be similar to the bottom liner installation; however, care must be taken in the clay liner placement to prevent its contamination. This will be done so that subsequent cover liner and drainage layers can be installed as a clean zone activity. The final cover installation progresses across the final grade as the waste cell will be filled until the waste cell is covered as shown in Figure 9-1.

The waste cell construction process will be repeated until all the contaminated sites at RMA are cleaned up and the waste cells filled.

III.3.2 Waste Control

Waste control activities will include mapping the location of wastes in the waste cell, controlling the combination of wastes to minimize contaminant releases, and estimating the compacted volume of wastes. Waste cell mapping will provide a location and elevation map and inventory of where the contaminated materials are to be placed in the waste cells. This mapping will require a waste analysis plan with accurate field surveys of waste placement; accurate haul truck weights; and representative estimates of the compacted density of contaminated material.

A waste analysis plan will be developed to address the issues of waste control and will incorporate:

- O General and specific requirements as specified in 40 CFR 261, 264, 268, and other Federal/state.
- Methods for addressing landfill disposal restrictions.
- o Preacceptance chemical testing results to separate incompatible wastes.
- o Representative sampling and QA/QC procedures for the RMA indicator contaminants or other substance lists from the regulations (such as 40 CFR 261.11 Appendix VIII or CERCLA hazardous substance lists).
- O Determination of physical tests or estimation practices for bank volumes, loose volumes, and compacted volumes of contaminated materials at RMA sites as required for planning purposes.

- Results of waste leachability tests followed by waste-to-liner compatibility testing for contaminated materials with high total organic carbon (YOC) or total organic halogen (TOX) content leachates (greater than 10,000 ppm TOC or 1,000 ppm TOX).
- Testing procedures for spill identification, stormwater, and groundwater control analyses, leachate treatment analyses, dust control, and other air monitoring.
- o Frequency of testing, type of sampling, and data evaluation for waste analysis plan.

The construction sequence worked out on the basis of this testing will ensure incompatible wastes are not placed together, as described in Section 3.6.2, Waste-to-Waste Compatibility.

Settlement will be controlled by proper waste compaction and limited placement of building debris in any one waste cell. Small quantities of building debris or bulky wastes are expected to be placed in the center region of the waste cell (approximately 0.5 to 5 percent building debris per waste cell). Minimum settlement will ensure the integrity of the waste cell cover (the top barrier is not breached or the drainage pattern disturbed as a result of differential settlement).

III.3.3 Waste Cell Operation

Waste cell operations will consist of three primary actions. The first action will be the excavation or demolition of contaminated materials at RMA. These contaminated materials will then be hauled to the working face of the land disposal sites. The third major action will be the placement of waste in the waste cell. These operations will continue until the waste cell is filled to its final grade.

Excavation or demolition work will continue until concentrations of indicator compounds at RMA sites meet designated clean levels. The site excavations

will be performed using large bulldozers and loaders. Bulldozers will windrow contaminated soils for loading into haul vehicles. For deep contaminated sites (greater than 20 feet), a dragline may be used for contaminated soil excavation. A backhoe or power shovel may be used to excavate contaminated material from small sites or "hot spots" (i.e., small, heavily contaminated areas). The building demolition area could use a variety of demolition equipment (wrecking balls, cranes, fork lifts, and loaders). Whether by excavation or demolition, site cleanup operations will minimize contaminant migration from the contamination zone by decontaminating personnel and equipment leaving the contamination zone. Surface water runon will be controlled to avoid contaminated runoff. Dust suppression measures will be applied as required.

Wastes from excavation or demolition of RMA sites will be loaded into off-road dump trucks and covered before transport to the land disposal facility working face. The loading operation will be in the cleaned portion or lightly contaminated areas of the contamination zone. The trucks will have their wheels and undercarriages steam cleaned, as required, in a decontamination zone surrounding the site contamination zone before hauling the site wastes to the waste cell. Paved roads will be used to minimize dust for the anticipated year-around waste removal and hauling operation.

The third waste cell operation will be the placement of waste. Unlike land disposal facilities excavated for underground waste placement, the facilities will be above-ground level. Waste placement will begin at the lowest point of the bottom liner, inside the waste cell berms.

Phased Cell Construction Method

The phased cell construction method is shown in Figure 9-2. Two ramps are required, one for waste placement and one for waste cell construction. The first year, waste trucks will use the waste placement ramp at the middle of the waste cell and the next year the back end ramp. The waste placement would be parallel to the sawtooth leachate collection system, so that the sawtooth can provide some isolation of the contamination zone, from the decontamination

sone in the bottom of the waste cell between the contamination zone and decontamination zones. The waste could be push up slope for the first two-thirds of the waste cell; an area lift method will be used to work the waste lifts up to grade in the ramp-up area. This waste placement technique will be utilized to minimize the exposed working face and to support phased cover operations. At the proper time, the decontamination zone will be moved outside the waste cell to the top of the back ramp in a paved and lined decontamination area. In the back end of the waste cell, as horizontal area lifts are built, bulky waste and building debris will be placed near the berm height in the center of the waste cell to prevent liner puncture and to control differential settlement from too much bulky waste or building debris in any one location. Building materials will be placed so that voids will be filled to prevent settlement.

If there are idle periods between construction seasons for the large waste cell, there may be large exposed areas of waste at final grade. An intermediate sand cover will be installed to reduce contaminant migration and to connect the stormwater runoff from the unfinished final grade to the leachate collection system. Waste placement is anticipated throughout the year, weather permitting, and the exposed working face will be minimized during operations.

Completed Cell Construction Method

The completed cell construction method is shown in Figure 9-1. Only one ramp will be used to place waste in the waste cell. The decontamination area will be at the top of the ramp. Waste can be placed in horizontal lifts across the entire bottom of the waste cell because of the smaller waste cell size and shorter duration of waste exposure to precipitation.

The advantage of the completed cell construction method is the completion of a waste cell from construction to final cover in one construction season.

While more exposed area may exist from the use of an area filling technique versus an inclined face technique, waste compaction is simpler, and less potential contaminated runoff generation is expected with this technique.

The completed cell construction method can mean seasonal employment with a skeleton crew of inspection, laboratory, and QA personnel. Winter waste placement is not always desirable because of the risk of freeze-thaw problems with the exposed clay bottom liner unless substantial protection is provided.

III.3.4 Land Disposal Equipment and Maintenance

A land disposal operation that requires the movement of 16 million bey from cleanup sites as much as 2 miles to the on-site disposal facilities will require careful attention to earth-moving equipment selection. At a concept design level, the daily waste handling volume, haul distances, waste cell size, and liner systems will be used to establish the equipment needs for waste cell construction, waste cell operations, and miscellaneous support equipment.

Waste cell construction will require the development of 10 to 100 acres per year, with an anticipated average of 40 to 60 acres per year over a ten year buildout period. The disposal site must be cleared of top soil and the site graded. This operation will require motorized scrapers, large bulldozers, loaders, and off-road dump trucks. Construction of access roads, waste cell berms, top soil stockpiles, clean sand borrowing operations, and bottom liner installation will also require this equipment, plus sheepsfoot rollers and road graders.

Waste cell operations will excavate or demolish, haul, and place approximately 400,000 to 2,500,000 bcy per year of waste, with an average of 1.5 million bcy per year for a 10 year buildout. Therefore, more than a half dozen types of equipment will be operating simultaneously on-site, with 20 to 60 pieces of earth-moving and demolition equipment supporting site cleanup activities. This equipment can include:

- o Bulldozers to windrow near-surface contaminated soil, build waste cell lifts, and demolish small structures.
- o off-road dump trucks.

- o Draglines to excavate sites with deep soil contamination.
- o Backhoes for small-site excavation and to load demolition waste.
- o Scrapers for placing clean soil.
- o Sheepsfoot rollers to compact contaminated soil in the waste cell.
- o Wrecking balls, cranes, and fork lifts for demolition work.

This could mean 20 to 60 pieces of earth-moving and demolition equipment operating to support the site cleanup activities.

To support waste cell construction and waste cell operations, there will be maintenance equipment for roads and vehicles, fueling vehicles, personnel transport vehicles, pug mill equipment, decontamination equipment, special demolition equipment, and utilities support equipment.

This equipment can include:

- o Road graders, street sweepers, and water trucks for road maintenance and dust control.
- o Tire trucks, tow trucks, and fueling trucks to support heavy equipment operation.
- o Pickup trucks to transport supervisory, health/safety, QA/QC, and operating personnel around the site.
- o Pug mill for soil/bentonite mixing.
- o Steam cleaners for decontaminating tires and undercarriages of vehicles leaving the contamination zone for the support zone.

o Sump pumps, fuel storage pumps, fire fighting equipment, water pumps, and water treatment equipment for utilities support.

This equipment will be housed and/or maintained in a 15,000 square foot heavy equipment maintenance building. The building will have a maximum of a month fuel supply and a two day water supply.

A maintenance program for the land disposal facility equipment will be established either by specification requirements in the final design or by contractual obligations for leased equipment by the general contractor for waste cell construction and waste cell operation. It is common to have as much as 10 to 15 percent of land disposal equipment in maintenance at any one time for a large disposal operation. This is due primarily to the severity of the working environment and equipment operations. This maintenance cost can be 5 to 20 percent of annual operating cost, depending on the items included.

III.3.5 Personnel Requirements

Site cleanup and disposal operations are expected to require 30 to 100 workers. These workers are required for the following functions:

- o Supervisory personnel, including site manager, foreman, and laboratory, health and safety and QA/QC managers.
- o Laborers for heavy equipment operations and maintenance.
- o Technical staff (laboratory personnel, waste samplers, field QA/QC, and health and safety inspectors).
- o Administrative personnel (recordkeeping, training, and security).

III.3.6 Environmental Control

Environmental controls will be required for the three primary contaminant migration pathways: stormwater, leachate, and dust. As stated in the waste cell operations section, the active working face and exposed waste areas will

be minimized to reduce leachate, dust, and contaminated stormwater with either the phased or completed cell construction methods.

Stormwater control will be required at the cleanup of individual sites and at the waste cell operations. At the site cleanup, excavation will be conducted from the highest to the lowest portion of the site. Temporary upland drainage may be required to reduce stormwater run on. Any contaminated equipment will be decontaminated before moving off-site to the waste cell. The clean site will be backfilled, regraded, and revegetated to control stormwater.

The land disposal site will require the following stormwater control system:

- o Stormwater detention pond;
- o Stormwater treatment (carbon absorption for contaminated stormwater);
- o Stormwater drainage ditch system constructed from the lowest to highest portion of the site; and
- o Final cover placement and waste cell revegetation while waste cell operations progress (estimated to involve 40 to 60 acres per year).

The operational performance of this system will be inspected to ensure stormwater control, as described in Section 9.3.8.

The leachate control system is described in Chapters 6 and 7. The system will incorporate a number of features that will improve its operation:

- o There are to beno barrier penetrations in the bottom FML. The leachate generated during waste cell installation will be pumped out through the cover.
- o The sawtooth leachate collection system running the length of the cell will be relatively easy to clean out and inspect. It will also improve the separation of the decontaminated zone and support zone.

- o Leak detection in the cover will allow earlier identification and repair of leaks to keep water out of the waste cell.
- o Placement of additional soil material over the bottom liner will protect it from damage and reduce leachate generation.

The leachate control system will be operated by inspecting and pumping out leachate sumps to leachate tank trucks for transport to leachate treatment facilities. Leachate will be evaporated. No leachate generation and very limited contaminated runoff is to be expected during active filling, and even less during the post-closure care period and beyond. The leachate system performance will be checked by the leak detection system, leak detection devices (moisture detectors), and groundwater monitoring wells, as described in the site monitoring plan, Section 9.3.8.

Dust control will involve the use of water and/or dust suppression chemicals; vehicle decontamination procedures; use of paved roads and the cleaning of these roads; rapid revegetation of cleanup sites and disposal areas; and shut down of operations during high wind conditions (greater than 35 mph).

During the summer months, water be used to control dust at RMA sites and the disposal operation. Vehicle tires and undercarriages will be steam cleaned, as required, before leaving the contamination zones at RMA sites and the disposal facility. This operation will reduce the need for street sweeping of the paved road to control dust in the construction season. Other operational controls for high winds and rainfall will be used to further support the preceding activities. Additionally, sites will be revegetated rapidly to further minimize fugitive dust emission. Site monitoring will be used to ensure acceptable air quality.

III.3.7 Emergency Response Plan

The operating plan will include preparedness, prevention, and contingency plans for emergency response. The preparedness and prevention plans will include equipment, access to communication devices, and access of personnel

and equipment through the area. The equipment will include intercoms, alarms, two-way radios and base station, telephones, fire protection equipment and supplies, and emergency power.

The contingency plan will be developed for the following events:

- o Fire/explosion
- o Spill or release of material or waste
- o Flood/precipitation event
- o Loss of electrical power
- o Leak detection system contamination
- o Unknown and uncontrolled reactions

Notification and contingency plan implementation procedures will be developed for both the site cleanup and disposal site areas.

Th plan will include the following items, as specified in 40 CFR 265:

- o Procedures to be followed for fire, spills, explosion, and other uncontrolled releases;
- o Procedures to be followed for flood/precipitation or loss of electrical power events;
- o Procedures to be followed for exceeding concentration limits in daily uncontaminated runoff samples of or escape of contaminated or potentially contaminated runoff from the facility;
- o Procedures to be followed for discovery of contaminated groundwater within or outside the facility compliance boundary;
- o Procedures to be followed for discovery of hazardous constituents in a waste cell leak detection sump;

- o Procedures to be followed if hazardous constituents are identified in detection sump;
- o Reporting requirements;
- o Emergency coordinator availability;
- o Amendment of contingency plan;
- o Copies of contingency plan;
- o Arrangements; and
- o Emergency response training for outside agencies.

III.3.8 Site Monitoring

The following regulatory requirements, as specified in 40 CFR 264, apply:

- o The groundwater monitoring program must include a determination of the groundwater surface elevation each time groundwater is sampled.
- o The unit must be inspected weekly and after all storms to ensure that systems are still in place and working correctly.

The effectiveness of the design must be evaluated periodically to ensure that the land disposal facility is meeting the two principal objectives of providing waste containment and preventing contaminant generation and migration. The evaluation will be accomplished through a monitoring program for: flowing or standing water in the primary leachate collection system piping or sumps; the presence of leachate in the leak detection systems; the presence of contaminated groundwater or surface water; the presence of contaminated dust particles and hazardous gas emissions in the air.

The well monitoring system incorporated into the facility design will provide the means of monitoring the groundwater in accordance with closure and post-closure plans developed for the facility. Plans are to be prepared in compliance with the previously described regulations. The prescribed inspections will ensure that the physical features of the facility are in satisfactory operating condition.

III.3.9 Quality Assurance/Quality Control

The QA/QC program for operations is to be similar to that for construction. All waste placed in the cells must be mapped as to location, traceability established to the point of origin, and all samples and tests performed on the waste. The QA/QC program will conform to the EPA Technical Guidance Document, Construction Quality Assurance for Hazardous Waste Land Disposal Facility - EPA/530-SW-01, 1986.

III.3.10 Health and Safety

This section will discuss work zones; Level B protection for heavily contaminated site cleanup; vehicle and personnel decontamination requirements; special modifications to earth-moving equipment to operate in Level B; health and safety plan development.

Work zones are an important concept for both site cleanup and land disposal operations. There are three basic work zones: contamination zone, decontamination zone, and support zone. The contamination zones are within the site cleanup boundaries, where contaminated materials are excavated or demolished, and within the waste cell where wastes are placed. The decontamination zone is a transition zone between the contamination and support zones. This zone is for decontaminating personnel and equipment leaving the contamination zone for the support zone. The support zone is a clean area where support materials and equipment are stored. The work zone concept will be used to minimize the migration of hazardous substance away from the site cleanup and disposal areas.

The use of Level B protection for site personnel is anticipated for the heavily contaminated sites (e.g., Basin F). This level of protection means use of self-contained breathing apparatus and protective clothing, up to complete enclosure of the worker. Personnel protection clothing and equipment can restrict sight and movement with significant loss of worker productivity. To minimize worker productivity losses with Level B protection, the operating equipment will be modified. The heavy equipment operators will be enclosed in either a self-contained equipment cab with air conditioning and supplied air, or a modified cab with air supply and Level A protective clothing, and mobile air supply and lines to reduce potential heat exhaustion.

For lightly contaminated sites and disposal operations, lower levels of personnel protective clothing and equipment will be used.

In either case, personnel and equipment will be decontaminated before moving materials from the contamination zone to the support zone. The selection of decontamination solutions is defined in the Health and Safety Plan. These decontamination procedures for both personnel and equipment help ensure minimum contaminant migration from the cleanup sites and the waste cells.

A Health and Safety Plan will be developed in the detailed design phase to assist the cleanup and waste cell operation contractors in protecting their workers. A health and safety manager will administer the construction contractors' health and safety plan development. The plan will cover, at a minimum, site safety procedures as well as the following items:

- o Identification and description of site
- o Identification of hazards
- o Development of hazard reduction plans
- Selection of personnel protective clothing and equipment

- o Selection of personnel and equipment decontamination procedures
- o Identification of chain-of-command and responsibilities
- o Development of emergency response plans

This plan will also address how maximum excavation production will be achieved by a clear statement of cleanup levels, the extent of contamination for excavation and demolition, and the use of hazard reduction plans, particularly for demolition work to downgrade personnel protective equipment and clothing level of protection.

111.4 SITE CLOSURE AND POSTCLOSURE CARE PLAN

III.4.1 Final Site Restoration

Final site closure will include activities such as the decontamination and restriction of roads, stormwater detection pond, temporary support structures, placement of riprap and soil over leachate pond, and placement of site identification monuments.

The placement of final cover on the last waste cell will occur after proper decontamination procedures are accomplished on roads, equipment, temporary support structures, and stormwater detention pond. The waste from this final decontamination procedure will be placed in the last waste cell. The decontamination wastewater will be placed in the leachate treatment pond.

After the post-closure care period, the leachate treatment pond will be modified to act as a drainage field for the leachate from any failed waste cell. Riprap and soil will be placed over the leachate treatment pond with the surface revegetated.

Upon completion of the post-closure care period, each waste cell will have a site identification monument installed. This monument will provide site identification in formation to alert future land use planners about this area.

III.4.2 Site Monitoring and Post-closure Care

The closure and post-closure care for a hazardous waste landfill will involve the development of closure and post-closure care plans. Within these plans, closure performance is measured by two criteria. These criteria are to minimize the need for further maintenance and to prevent threats to human health and the environment. Within 90 to 180 days of the completion of operation, final closure will be initiated unless the process necessitates a longer time period. Following final closure, the site will function with minimum maintenance.

The post-closure care plan will provide the following guidance to the owner and operator of the facility:

- o The integrity of the final cover must be maintained by making necessary repairs to the cap required as a result of settlement, subsidence, erosion, animal intrusion, or other events.
- o Maintain and monitor the leak detection system where present.
- o Operate leachate collection and removal systems until leachate is no longer detected.
- o Maintain site vegetation to prevent deep rooted plants from becoming established.
- o Monitor and maintain a groundwater monitoring system.
- o Prevent erosion or damage from runon and runoff.
- o Protect and maintain survey benchmarks used to comply with regulations on land use identification.
- o Report leaks in leak detection system to appropriate authorities.

Another element of the post-closure care period and beyond will be the use of the property. RCRA regulations, Subpart G, 40 CFR 264.117, Postclosure Care and Use of Property, describe post-closure use of property. Where hazardous wastes remain after closure, a land use must never be allowed to disturb the integrity of the final cover, or other components of the containment system, or the function of the facility's monitoring system, unless the EPA Regional Administrator approves the proposed disturbance. If the proposed land use would disturb the site, the Regional Administrator judges whether the disturbance:

- o Is necessary to the proposed land use of the property and will not increase the potential hazard to human health or the environment; or
- o Is necessary to reduce a threat to human health or the environment.

Other requirements of the owner include the following:

- The owner or operator must inspect his facility for malfunctions and deterioration, operator errors, and discharges that may cause, or lead to: 1) release of hazardous waste constituents to the environment; or 2) a threat to human health (40 CFR 264.15).
- o An owner/operator will provide continuing operation and maintenance of the leak detection systems during the active life of the unit, the closure period, and the post-closure period (40 CFR 264.90).
- The groundwater monitoring system must consist of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that: 1) represent the quality of background water that has not been affected by leakage from a regulated unit; and 2) represent the quality of groundwater passing the point of compliance (40 CFR 264.97).

III.4.3 Quality Assurance/Quality Control

These requirements are similar to those described in Section 9.3.9, except that barring possible failures, there are less activities to document during closure and post-closure periods.

Of particular concern during the post-closure period is the integrity of the closed waste cell. The following systems would be monitored over this post-closure period to verify the performance of the waste cell during this period:

- o Waste Cell Leak Detection System Monitoring
 - Semi-annual cover system monitoring to initiate cover repair as necessary.
 - Semi-annual bottom liner system monitoring to initiate waste cell repairs with leachate collection or complete removal of the waste cell, as necessary, with leachate in the bottom liner leak detection system.
- o Leachate System Leak Detection System Monitoring
 - Same as waste cell bottom liner leak detection system monitoring.
- o Semi-annual groundwater monitoring to ensure contaminant migration past the waste management unit boundary in the post-closure care period.

Waste cells that pass through this period without contaminant release will be examined on a less frequent basis. Waste cells that fail to pass through the post-closure period without a release will be repaired or replaced, and the post-closure care period extended until the waste cell is demonstrated to be free from contaminant releases.

III.5 SCHEDULE

The total buildout period for the facility can vary depending on a number of factors, such as construction economy and the target date for completion of RMA cleanup. The first and last years are allocated to construction of facilities and closure activities, respectively, with the waste excavation, transport, and placement occurring entirely in the period between first and last years.

In the following Appendix, buildout periods of 5, 10, 20, and 30 years are examined and cost estimates displayed for each. These periods include the first-year facilities' construction and the final-year closure activities.

Cells built by phased construction will be started in the spring. Should the climate require a halt in construction during the winter, construction will continue until enough waste volume capacity is built to last until the next construction season. Upon reaching grade, final cover will be installed. In the fall, final cover and waste cell construction operations will be secured for the winter if necessary. Waste placement would continue on a year-round basis.

An annual construction cycle would consist of building, filling, and covering an entire waste cell in one construction season from the spring to fall. This type of operation may be applied to the smaller waste cell sizes (e.g., less than 1,000,00 ccy). A skeleton crew will be kept on-site through the winter months to monitor the site, to maintain equipment and records, and to review the next construction season's site cleanup activities and operating plans.

APPENDIX IV

COST ESTIMATE DETAILS

3 TRANS BUSINESS MERITA - IN LANCESS TRESING - 250 INCLUSING CLOSIC TIME CELLS

Marty Hountain Arsamal - URBT 5558, 784 TABK 27

Electo Services Inc.

Estimate of Neste Transmetation Costs for a 5 Year Buildout Period

i i

Maste transportation costs are estimated in two parts: Meal costs (Table 2) and Loading/enloading costs (Table 3).

Maste Transportation Costs to sites 1 and 6 (Sumution of tables 2 and 3) are presented in Table 4.

The first and last years of the buildout period are used for facility construction and closure, respectively.

Leading/enloading costs are wifors throughout the buildout period.

Energement production rates are based on 50 minute hours (SIS efficiency).

Evergement production rates were astimated from the 12nd, of the Cateroillar Performance Maddood.

Exergement costs are based on an hearly restal free that includes overhead for a driver, a mechanic, fuel, maintenance and seare parts.

Revisional costs were provided by EMSCO Constructors Inc.

HALL CUSTS

theil costs are considered to be costs associated with the transportation of waste from the contamination site to the land disposal facility.

Newl costs are calculated individually for sections. Whete volume in sections were taken from the DMLF or the Phone I Contamination Assessment Reports if available.

Table I provides an estimate of the fleet size and time required to transport waste from sections to disposal sites 1 & 6. Heal distances were measured from the centur of "sections" to the centroid of the diseosal site via the existing road grids.

Newl costs depend on heel distances and thus vary over the buildout seriod.

Whate material is transported in and damp haw! trucks toff-road size).

A semeny of heal costs by sections are presented in table 1 for both sites 1 and 6.. The annual "hast costs" for transportation of maste material is presented in table 2.

Equipment Specifications

End down has litruck (Caterpillar 765C, p. 226)

Easty vehicle seight (EW)= 68,0001b Gross vahirile weight (BMI)=138,00016

* 70,00016 or 35 tons = 29.8 cv (street) Canacity

Estimation of heal truck production rates

Haul truck production rakes are a function of the travel time to and from the centamination site and land dissonal facility. The total round trip travel time is the son of the haul time, return time and load/unload time. The haul times and return times can be estimated by equations 1 and 2 derived from the Caternillar Handbook (a.233-234).

The load/emload time is an assumed constant.

were It is in feet, based on the BM and a total resistance of 45 (25 rolling + 25 grade) Eg. (f) Haul ties (min) = 0.20 + 4.61E-4(K)

Eo. (2) Neturn time (ain): 0.24 + 2.50E-4(1) mere I is in feet, based on the EW and OK total resistance (2x rolling and -2x grade)

Inget parameters for calculation of Table 1 and 2.

	260 (5 days/week-52 weeks/year)					
5	æ	9	-	2.15	E .3	2. 610.057
Meste placement years	Construction days per yours	Hers per days	Degin neate placement at end of year	Lead/unload time (minutes)=	Hourly 769C rental fee (9)=	Owners to parameter (III)

TMALE I Required fleet size for Transportation of waste to sites I and 6

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	经现代法法证证 人名人名英西西西西西西西西西西西西西西西西西西西西西西西西西西西西西西西西西西	44444467444 444 4446744	**************************************	8	2.4 2.5 2.5 2.5 2.5 2.5 2.5 2.5 2.5 2.5 2.5	6.81 7.94 3.67 4.20 4.20 4.20 4.20 4.20 4.20 4.20 4.20	15,000 6.81 7.04 3.67 4.20 22,120 6.81 10.06 3.67 3.67 3.77 3.12 11,520 1.23 5.76 0.77 3.12 11,520 1.23 5.76 0.77 3.12 11,550 1.23 5.78 5.78 5.78 5.78 5.78 5.78 5.78 5.78	13,700 15,840 5.81 7.84 3.67 4.20 13,700 15,840 5.81 10.86 3.67 3.77 3.12 5.160 15,800 1,23 5.76 0.77 3.12 5.160 15,800 4.27 8.36 2.35 4.45 0.07 13.20 15,800 4.27 8.30 2.35 4.45 0.07 13.50 15,800 4.27 8.30 2.35 4.45 0.07 15,800 15,800 6.31 5.78 3.41 3.13 0.07 17,900 11,360 6.31 5.78 3.78 3.73 3.13 3.13 0.07 17,900 11,360 6.31 3.22 3.34 3.13 3.13 3.13 3.13 3.13 3.13 3.13	2, 185, 1800 13, 700 15, 840 6, 81 7, 84 3, 67 4, 20 1, 715, 800 13, 700 22, 120 6, 81 10, 86 3, 677 3, 77 3, 12 122, 100 13, 200 15, 200 15, 200 15, 200 15, 200 15, 200 15, 200 15, 200 15, 200 15, 200 15, 200 15, 200 15, 200 15, 200 17, 200 17, 200 17, 200 17, 200 17, 200 17, 200 17, 200 17, 200 17, 200 17, 200 17, 200 17, 200 17, 200 12,
	8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	######## =============================	F 2 2 3 2 2 2 8 8 8	19 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	10	6.01 10.05 3.67 3.77 1.23 1.23 1.24 1.20 1.24 1.24 1.24 1.24 1.24 1.24 1.24 1.24	22,120 6,61 10,66 3,67 3,77 3,12 11,520 11,23 5,78 0,77 3,12 11,520 11,23 5,78 0,77 3,12 11,520 1,23 1,23 1,23 1,33 1,33 1,33 1,34 1,34 1,34 1,34 1,3	00 13,700 22,120 5,611 10,66 3,67 3,77 3,12 5,100 11,520 11,23 5,76 0,77 3,12 5,100 11,520 11,23 5,76 0,77 3,12 5,100 11,520 11,27 6,28 5,78 3,41 3,13 5,100 17,340 11,550 6,31 5,78 3,78 3,13 1,13 5,100 11,540 6,31 3,13 3,13 3,13 3,13 3,13 3,13 3,13	1,775,000 13,700 22,120 6,81 10.06 3.67 5.77 3.12 17,300 2,100 11,520 1.23 5.76 0.77 3.12 122,000 6,420 16,800 4,27 6,22 5.35 4,45 1,000 12,600 12,600 4,27 8,30 5.35 4,44 1,000 17,900 11,550 6,31 5.78 3.78 4,73 3.13 1,000 17,900 11,550 6,31 3.22 3.42 1.00 16,31 3.22 3.42 1.00
		******	25222888 444441.			1.23 AN P. C.	11,550 1.23 5.75 0.77 3.12 16,500 1.23 5.75 0.77 3.12 16,500 1.27 8.39 5.35 1.55 11,500 1.27 8.39 5.30 1.35 11,500 1.37 8.33 1.35 1.35 1.35 1.35 1.35 1.35 1.35 1	00 2,100 11,320 1.23 5.75 0.77 3.12 00 8,420 16,800 4.27 8.30 2.35 4.45 00 8,420 16,800 4.27 8.30 2.35 4.45 00 12,660 11,350 6.31 5.78 3.41 3.13 00 17,900 11,350 8.65 5.78 3.41 3.13 00 17,900 11,350 8.65 5.78 3.41 3.13	17,300 2,100 11,320 1.23 5.76 0.77 3.12 122,000 8,420 16,800 4.27 8.30 2.35 4.45 1,000 12,600 1,27 8.30 2.35 4.45 1,000 12,600 11,360 6.31 5.78 3.41 3.13 1,000 17,900 11,360 8,20 8,30 3.22 3.42 1.00 16,31 3.22 3.42 1.00
	44:11.44.4 32886868	* * * * * * * * * * * * * * * * * * *	\$ \$ 2 2 8 A \$				16,000 4.27 6.22 2.33 4.45 16,000 4.27 8.23 2.33 4.45 11,300 6.31 5.72 1.43 3.13 11,300 6.31 5.72 1.43 3.13 4,73 3.13 1.45 6,700 6.07 2.25 4.74 1.30 6,700 6.07 2.25 1.75 1.00	1,200 15,800 4,27 6,32 2,33 4,45 12,80 15,800 4,27 8,30 2,33 4,45 12,80 11,340 6,31 5,78 3,41 3,13 17,900 11,350 6,31 5,78 3,78 4,73 3,13 12,79 6,33 3,42 3,42 1,80 12,79 6,33 3,42 3,42 1,80 12,79 6,33 3,42 3,42 1,80 12,79 6,33 3,42 3,42 1,80 12,79 6,33 3,42 3,42 1,80 12,79 6,33 3,42 3,42 1,80 12,79 6,33 3,42 3,42 1,80 12,79 6,33 3,42 3,42 1,80 12,79 6,33 3,42 3,42 3,42 3,42 3,42 3,42 3,42 3	122,000 6,420 16,800 4,27 6,32 2,33 4,45 1,40 1,27 6,3 2,33 4,45 1,40 1,27 6,3 2,33 4,44 1,00 12,60 11,560 6,31 5,78 3,78 4,73 3,13 15,00 12,70 11,560 6,33 3,22 3,42 1,00 16,30 12,710 6,30 3,42 1,42 1,40
	3 1 1 7 4 7 4 8 5 8 5 8 5 8 5 8 5 8 5 8 5 8 5 8 5 8	3.5.5.5 3.0.5.5 3.0.5.5 3.0.5.5 3.0.	3 T T 8 A 4		81	4.27 9.30 2.35 4.46 4.31 3.13 9.13 9.13 9.13 9.13 9.13 9.13 9	15,000 1,27 8,30 2,35 4.44 1,300 1,27 8,30 3,41 3,13 1,150 6,31 3,22 3,42 1,30 4,44 1,	12,420 15,800 4,27 8,30 2,35 4,44 12,50 11,30 6,31 5,78 3,41 3,13 17,90 11,350 6,31 3,22 3,42 1,20 12,79 5,20 6,33 3,42 1,42 1,42 1,42 1,42 1,42 1,42 1,42 1	95,000 0,420 16,800 4,27 8,30 2,35 4,44 1,000 12,660 11,550 6,31 5,78 3,41 3,13 1,000 17,940 11,550 0,633 3,22 3,42 1,000 16,31 3,22 3,42 1,000
	* * * * * * * * * * * * * * * * * * *	2.5 2.07 2.09 2.10 2.11	T E S S S	141 141 141 141 141 141 141 141 141 141	14 14 13 13 13 14 15 15 15 15 15 15 15 15 15 15 15 15 15	6.31 5.78 3.41 3.13 6.65 6.73 3.13 6.53 6.53 1.20 1.00 6.53 6.53 1.20 1.20 6.54 6.74 1.30	11,550 6,31 5,78 3,41 3,13 11,550 11,550 1,65 5,78 4,73 3,13 11,550 6,33 3,22 3,42 1,30 4,74 1,30 6,30 6,33 3,22 3,33 1,60 6,30 1,30 1,30 1,30 1,30 1,30 1,30 1,30 1	12,660 11,550 6,31 5,78 3.41 3.13 17,900 11,550 6,45 5,78 4,73 3,13 12,710 6,20 6,33 3,22 3,42 1,69	1,000 12,660 11,550 6.31 5.78 3.41 3.13 1,000 17,940 11,550 8.65 5.78 4.73 3.13 163,600 12,710 6,240 6,33 3.22 3.42 1.00
	11.8 25.7 8 25.7 8 25.7 8 25.7	2.07 2.07 7.11	# 8 A 8	4.73 1.18 3.42 1.80 4.4 1.30	1.13 1.13 1.13 1.13 1.13 1.13 1.13 1.13	6.13 3.22 3.42 1.60 6.83 8.73 8.13 8.13 6.13 6.13 6.14 6.14 6.15 6.15 6.14 6.14 6.15 6.15 6.15 6.15 6.15 6.15 6.15 6.15	11,550 p.65 5.78 4.73 3.13 5.20 p.73 3.13 5.20 p.73 3.13 7.20 p.73 5.20 p.73	17,940 11,350 0,05 5,78 4,73 3,13 12,19 6,24 5,25 3,42 1,09	1,000 17,940 11,550 6.33 3.22 3.42 1.80
		2.87	8 8 8	3.42 5.74 1.30 1.30	3.22 3.42 1.38 8.4 4.74 1.30	6.33 3.22 3.42 1.80 6.87 2.26 4.74 1.30	6,240 6,33 3,22 3,42 1,80 4,24 1,30 6,33 3,22 3,33 1,30 6,30 6,23 3,22 3,33 1,30 1,80	12,710 6,200 6,33 3,22 3,42 1,60	163,600 12,710 6,240 6,33 3,82 3,42 1.00
		7.	A 5	8.1 % T	2.24 4.74 1.30	6.87 2.26 4.74 1.30	4,240 ft.87 2.25 4.74 1.30 ft.80 ft.80		
			\$				6.240 6.23 3.22 3.33 1.80	17,990 4,240 E.87 2,26 4,74 1,30	34,260 17,930 4,240 6.67 2.28 4.74 1.30
		'n	3:	8.1	3.7	6.23 3.22 3.31 1.60		12.30 6.20 6.23 3.22 3.31 1.60	169,000 12,300 6,200 6,23 3.22 3.37 1.00
		~:	8:	4.74 1.30	8.3 4.7 5.3	B.67 2.28 4.74 1.30	4.240 B.87 2.25 4.74 1.30	17,900 4,240 B.67 2,35 4,74 1,30	140,000 17,200 4,240 B.67 2,25 4,74 1,30
		oi	3.12	6.31 3.12	5.76 6.31 3.12	11.89 5.76 6.31 3.12	11.20 11.69 5.76 6.31 3.12	24.260 11.20 11.09 5.76 6.31 3.12	147,000 24,260 11,20 11,89 5.76 6,31 3.12
		~	31 %	3.12	5.76 4.28 3.12	S. 12 5.76 4.38 3.12	11.20 5.11 5.76 4.38 J.12	11.20 11.20	11.20 11.20
		~	KJ	K1 8.7	10.2 A.S. S.A.	K-2 8.4 2.01 12.2	22,040 9,35 10,94 4.99 5.78	18.50 22.000 9.35 10.55 4.99 5.78	18.50 22.000 9.35 10.55 4.99 5.78
		d	7.0	1,20	12.18 4.19 7.00	2.0 1.0 1.0 7.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1	27, 260 A.OK 12, M. V. W. 7, 00	16. 200 P. 260 P. 05 12. M. 0. 20 7.00	16. 200 P. 260 P. 05 12. M. 0. 20 7.00
			7.09	4.9	13.40 4.99 7.09	12.40 4.99 7.09	77,400 4.20 4.39 7.09	12.40 4.99 7.09	12.40 4.99 7.09
			2,23	2.5	14.46 7.63 2.73	14.46 7.63 2.73	77, 960 14,43 14,46 7,63 5,73	20 CS 18.43 18.48 7.63 573	20 CS 18.43 18.48 7.63 573
			•	<u> </u>					
								13, 335, 200	Total 13,335,200

THREE 2 FRIENT, HOLL COSTS SUTES 1 & 6

1987 PRESENT PRESENT PRESENT CXBT NORTH NORTH NORTH 1 SITE 6 FRCTOR SITE 1 SITE 6	0 1 0 0	4.384,135 0.3615 1,404,336 4	3,389,453 0,8946 2,252,691 3	4	€.	10 AND 1070 ALC AND 110 00 AND AND 1070
1997 0067 1598 SITE 1	_	3	3 2.43	3.07	5 2,71	200 - STORE - STORE

LONDANA CHO COSTS

Load costs are costs associated with electment of weste in heal trucks.

Unload costs are costs associated with electment and commercian of the weste at the land disposal facility.

Lead costs are broad on a dear to unidow made material and a leader to place the maste in a heal truck.

Placement costs are besud on a dear and mater grader to nove, level and compact the material at the land disposal facility.

Load/unload costs are prosociational to the weste placement rate and therefore are uniform.

Equipment Specifications

114,653	85,360 375 7	40, 630 150
Docer (Ceteroiller 89, p. 55) GMilbl= Flycheel poor* (hg)* Universal blade	Losder (Caterpillar 9988, p. 288) BANIB): Flydael pener (hg): Backet size (cy):	Mater Grader (Caternillar 148, p.73) SM(15)= Flydwel gener (hg)= Standard 14' blade

MALIAL LONDANICOS COSTIS -+ THE 3

ENTHERT		HOLELY Pice, NOTE (ICY)	HOLLY Notre (6)	RENTAL (6)	VEXAS Of operation	282 297 29. 782	PRESENT MONTH FACTOR	MESBIT
i i	2	1,826	8	EP4, 013	RP4,013 1-4.5	2,884,045	3.2	2,636,041
	N	\$5	*	636,646	Ţ	2,288,362	22	2, 037, 258
į	-	4	\$	167,533	<u>1</u>	656, 355	3.2	600, 105
Totale				91,648,192		45, 748, 672	•	45,274,214

^{• -} Load/unload coats are the same for sites 1 and 6 • - Besed on 16 hour days 250 day

²⁶⁰ days per year

S VERN BUILDING RERIGH - D CONCEPT DESIGN - 250 THOUSING CLUIC VAND CELLS

TARLE 4
MISTE TRANSPORTATION COSTS
FOR SITES 1 AND 6

ETEROTURE	SETTE 1 CRESTS 1987 (6)	SITE 1 MESON ACOMIN	SITE 6 COSTS 1967 (0)	SITE 6 MESSOTI MONTH
HALL COSTS (TRALE 2)	10, 192, 970	9, 427, 897	15,631,119 14,427,856	14,427,856
LORAULDIB (TABLE 3)-4	11,537,344	10, 546, 429	11,537,344 10,548,429	10,548,429
101A.	822 , 030, 314	822,030,314 919,976,326 927,364,463 924,976,284	827, 368, 463	R. 4. 976, 284

^{• -} A compensation factor has been added for level B worker proctection.

COST ESTIMATE FOR 5-YEAR BUILLOUT ON PRIMARY SITE

D-CELL CONCEPT

THO HADRED FIFTY THOUSAND CHOIC WAS CELLS (6.36" I 6.3" I 6.

THELE 1 CONSTRUCTION COSTS 517E 1

1184	SLEGTTY/ UNIT	URIT PRICE (8)	1387 1387 (8)	VEAN (8) -• CDIGT. COST OCCURS	1M171AL CDGT, 1967 (9)	MESBY -+++ LORIN FACTOR	MESBAT MORTH CONGT. COSTS VAS 1-4	MESENT MONTH COUST. COURTS YINS 0-4
lite Preparation Electing Brabling Earthwork-cet Earthwork-fill	690 acres 3, 150, 644 tery 3, 636, 678 tery	955 E E	630, 200 9, 451, 912 10, 910, 614	III	172,550 2,362,983 2,727,659		i	66.217 6,75,26 10,151,25
Coli Brus	11,271,910 tery	~	33,615,734		6,453,539	75	27,015,048	H, 45, 74
Supert Buildings and Equipment Administration bailding (40° x 60°) Personnel Decon, Trailer (6° x 12° 40°) Maintenance Building (60° x 20° x 40°)	2 2 2 3 3 4 3 4 3 4 3 4 3 4 3 4 3 4 3 4	8 8 8 8	120,000 270,000 130,000		270, 900 270, 900	98 1	• • •	124, 400 279, 400 130, 400
	400 H	19	90,00	•	90 00		•	%
Heel reads site ?	20,225 ft	8	4,611,250	I	•	3.630	4, 184, 709	4, 184, 709
Surface later Cantrol Bitch Batentien Ford (280'n 280'n 15') Leachate exercation and (200'n 200'n 9')	117,200 ft	40, 000 110, 000	744, 220 40, 000 110, 000	I • •	60, 600 110, 600	4 1 1 2 000 1 1 000 1 1 1 1 1 1 1 1 1 1 1	off Ki	673, 180 40, 000 116, 000
Manitoring Hells	8 %	2 980	19,000	•	19,000		•	16,000
Showity Fonce	ZK, 85% 14	&	537,880	•	537,880	1.88	•	537,880
Cell Construction(250,000 cy cell)	3	1,673,490	107, 103, 360	7	25, 775, 940	2.73	74,382,556	101,678,7%
9.6 TOTA.			164, 655, 230	•	# 1,620,650			0130, 276, 701
Engineering design, plans and seet's 1106 of total costs)	total costs)		16, 665, 923		16,665,923			16, 665, 923
Contingency fund (15% of total costs)			25, 278, 285		25,238,285			25, 258, 285
Total -			6210, 819, 038		963, 994, 658			1200, 472, 589

 ⁻ Construction costs accur at pass and.
 - Initial construction costs are considered to be expenditures occurred during the first 12 months of omfration (years 0 - 1).
 - Beard on a 4% discount rate (Interest rate - inflation rate)

THELE ? OPERATION AND MAINTENANCE COSTS SITE 1

	OPERATION CUSTS	OPERATION INSINTENDACE COSTS COSTS	1074. 1907 (s)	YEARS + Of Den	TOTAL	PRESENT -++ ACRTH FRCTOR	MESENT MORTH OM
deste transportation cost (Table 4)				3.5	22, 0.30, 314	,	19, 976, 226
Best Suppression	90,00	t	90,000	3.5	380,000	2	328, 160
Begort Belidings And Equipment Administration Perconnel Bacon/clean Trailors	000 vi	S S	5, 300 5, 300	in in	12,500	4.48	11, 130 24, 466
ibel /Access floats	•	20,000	30°00	10	100,000	4.68	99,040
Berface Hater Centrol System	•	\$,000	3,000	EC.	8	4.48	98 %
Sempling semitering wells (quarterly)	3,000	•	\$ 200	80	8	*	8,36
Mainistration Arramal	1		1	•	1		
1-Site Newsper	8 K	•		.			
1-Call construction former	88 ¢		000 st	* #i	157,500	20 7 20 7	2 2
2-Facilities former	98	•	90,000	-	360,000	35	28, 28
4-Laborers	120,080	,	120,000	80	600,000	4. 452	£.33
6-04/IC gersome)	122,000	,	192,000	3.5	672,000	33	\$7.78
	180,000	•	192,000	3.5	672,000	2.62	\$2.58 \$2.58
4-Field mainering support	140,000	,	140,000	3.5	490,000	20.2	399,280
2-Scale house technicians	80,00	,	50,000	3.5	175,000	73	142,600
4-Bacurity	120,000	,	120,000	.	600,000	4.45	54.26
2-morntans	40,000	•	40,000	¥n	200,000	3	178,080
• 52EE					\$56.881.814		P.A. 120, 220

 $\theta=Casts$ occur of years and $\theta=-Based$ on a 4% discount rate (Inderest rate-Inflation)

THRUE 3 CLOSUME COSTS SITE 1

	į		E 8	V691-4	MESSOT	PRESENT
		3	ŝ		5	
Becon, Personnel Trailors	•	3,000	15,000	3.5	0.872	13,079
December onto Man I Anne Committee I	47.243	173	141.729		0.872	123, 388
Section roads	15,000	m	\$ 080	3.5	0.872	38,240
Serface Mater Control	27 27	-	69.738		0.872	9
Pord (Resove)	-	\$ 000	4 00	3.5	0.072	4,360
	F		8276, 463		•	\$241.074

TABLE 4 Post Clobure costs Site 1

	COSTS	COENCITON INTERPRETE COSTS	TOTAL Dear	YEARS-4 OF OUR	TOTAL Data	PRESENT—46 LLORTH FRCTOR	MESON LEGRIN OF OUR
Support Buildings And Equipment Administration Building	000'1	85	1,500	R	45,900	14.212	21,310
Surface Mater Centrol Byston Bitch	•	1,000	1,000	R	30,000	14.212	14,212
Monitoring Wells	\$, 000	•	3,000	Я	130,000	14.212	71,060
Mainistration Personal Minager (sart time) Security Beard	25,000 15,000		15. 000 000	88	750, 000 450, 000	14.212	355, 300 213, 180
TOTAL.				•	51, 425,000		6675.070

^{0 -} Deals occur at years end so - Based on a 45 discount rate (interest rate - Inflation rate)

THUE S
COST QUERRY
S YEAR BULLOUT
SITE 1

	COSTS		
COBIN	130		
Construction (Table 1)	210,819,038 200,452,589	200, 472, 389	
Cheretien & Phin. (Table 2) 26, 881, 614 24, 120, 520	25, 851, 614	24, 120, 520	
Closure (Table 5)	276, 463	PM1,074	
Post Closure (Table 4)	1, 425,000	675,010	
TOTAL	ER 400, 314 825, 29, 25	12, 23, 25;	

e - Besed on a 4% discount rate (Interest rate - Inflation rate)

S YOM INTUIDAT FERIOR - 9 CONCEPT RESIGN - OF KITLION CABIC WAR CRLS

CHE PETRONE FOR S-VEHI RELIGION OF PRIVATA GUE.

GENT LANGE GUE OF THE CELLS (1004' I 1404' I 47" HUR!)

GENT PETRONE FOR SELLS (1004' I 1404' I 47" HUR!)

WELE 1 CONTRACTION COSTS SITE 1

							COST. COSTS (
		MIC 101						
Mie Poperalies	1	999	3	_	13.78	169		8
		7	11.15	I	27.78.673	3	7, 576, 122	19, 383, 625
		•	2.68.80		22, 38	31	1,378,451	1,066,191
Call Pres	3,522,600 key	. ~	11,656,400		05 'AR' 'S	159	F, 671, 124	11,645,7%
Court beliefers and Endonesia							•	
Strict Strict (Str. 160)	2.40 m. n	8	128,000	•	130, 251	8	•	
Brownel Brow. Trailor (Pt 12's 40')		8 8	8 8 8	•	8 'S	8	•	E E
thinkmance Driftdien 160 m 250"	7,380 es	8	35, 88 8	•	90, 92	<u>.</u>	• •	88.8
	E # 8	8	8,8	•	8	- 8	•	
Head reads talts 1	40,356 A	8	2,008,000	I	٥	168	1, 840, 410	1, 840, 410
Burfaco Mater Centrel	*	•	AN 864	1		177	78.547	3
	F 0.4	•			8		•	\$
Intention Verd (INV a SEV a 197)	E 8	15,98			110,00	8	•	110,000
_	,		•					
Manadering Malla	8	900'4	, č	•	, ē.	<u>.</u>	•	ž Š
	22,200 11	2	##, 88	•	444, 608	 8	•	# Y 8
			į	•	3		27 27	
Call Construction (I,000,000 cy call)	:			ī	K, W. 5	3		
			AM 84 811		478 174 869			0112.332.7%
10 TOTAL -								•
Engineering doubpe, plans and spec's (166 of total costs)	ial combal		11,946,094		11,946,094			11,945,894
			17,916,001		17, 914, 041			17,910,041
		•						
Total -		_	8149, 223, 673		866, 623, 884			

 ⁻ Construction costs occur of years and.
 - Initial construction costs are considered to be expenditures occurred during the first if wouths of operation (years 0 - 1).
 - Bession at 4% discount rate (inferest rate - inflation rate)

THALE & OFFICE (MAINTENNES CORTS SITE (

	COSTS	COSTS COSTS	15 8 15 15 15 15 15 15 15 15 15 15 15 15 15	YOU DE	TOTAL COST	MENENT +4 Moren Fretor	
Works transportation cost (Table 4)				3.5	22,030,314		19,976,385
Det Depression	20.42	•	98 '88	1.5	280, 600	2	3,48
Deport Delibings And Equipment Administration Personnel Desortions Trailors	2 8 2 8	8.8	95 s		12,380 27,300	3 3	= . 5 #
Ned Atoms Bods	•	20,000	89,69	**	100,000	j.	8,00
Berface Mater Centrol System	•	10 00 10	8	•	8	÷	32
Smalling mentering salls (querterly)	A.	•	A. 08	80	8	4.452	8
Absintation Personal							
1-8tte Manager	8 4	•	Ą	•	273,000	7.00	24, 250
1-Cell construction forms	**	•	Ą.	•	180,000	27	15,28
1-Meste pleasant forms	*	•	45, 800	3.5	157, 500	<u>ئ</u> ئ	35
E-facilities forms	*	•	8 , 8	•	# 'S#	1630	2
Hateren	129,000	•	120,000	S.	600,000	. f	£,45
E	18, 81	•	18 , 8	3.5	672,000	2	¥.7%
C-thealth & Shfaty personnel	18,98	•	192,000	3.5	672,000	2	¥ 25
4-field angineering support	18,00	•	140,000	23	450, 600	2	# · · · ·
2-Stale house technicisms	8 8	•	8	3.5	17,000	2	14,660
+ Bearity	130, 88 131	•	120,000	•	600,003	4	2,38
Petrotory	40 , 908	•	40,000	•	200,000	1	178,080
TOTA.					10, 001, 014		10.50

0 - Casts accer at years and 80 - Based on a 45 discount rate (Interest rate-inflation)

CLOBACE COSTS SITE 1

	MANUTY	1100 1200	TOTAL COST	TERM OF OF EXPENSE	MESBIT-++ LONDY FRCTOR	
Supert Buildings And Squippent Boom, Arramal Trailors		5, 080	15,600	3.5	283	13,079
Decentaments that these Longitudies reads on site 1 Dection reads	45 98,21	~ ~	5, 32 50 50 50 50 50 50	# # # #	4.672	52, FE
Sarface Mater Control Mitch (Second Part (Second	3 -	- 95	3, 78 80 . 2,	87 87 el el	9.672 9.672	25, 25 636, 4
	_	TOTAL.	9183, SA			1160,136

THRLE 4
MUST CLOBUTE COSTS
SITE 1

	eneral top	CONTRACTOR MAINTENACE		1588 -		MONTH FACTOR	
Separt bildings And Equipment Resinistration beliding	1,08		1,98	*	\$ 60	14.212	21,338
Barface Mater Control System Hitch	•	.; 98,	1,0	8	80 9	14.212	14,212
Amitering Ibils	**	•	8 8	8	139, 808	14.212	3, 2
Absinistration Personal Number (part tim) Security Board	4 zi	1 7	2) 2) 89 8	**	730,025 650,050	14.212	881 KIZ 13, 188
1818.				•	91,425,000		873,078

 ⁻ Couts acror of years and
 - Board on a 45 discount rate (interest rate - infliction rate)

THE S CAST SCIENTY S YEAR BULLION STRE 1 COUNTY COUNTY PRESENT—
CONSTRUCTION (Table 1) 145,282,673 142,244,289
Clower (Table 2) 25,881,814 84,184,289
Clower (Table 2) 25,881,814 84,184,289
Float Clower (Table 3) 15,485,600 675,070
WITH. 6177,814,133 9167,294,294

e - Beest en e 45 discount rate (Interest rate - Inflation rate)

CHAT ESTIMATE PAR 3-1920 MULLOUT ON PRINCET STITE
D-COLL COCKET
GRE 6 CHE NUL'S HILLION CADIC WAS COLLS 1 1004" X 1004" X 42" HIGH)
ESTIMATE 18 SHEED ON THE BISCURL OF 16 WILLION CY OF WITERIAL

THELE 1 CONSTRUCTION COSTS SITE 1

			į					
	CURTITY/ UNIT		180 COST	CONST.	187 (8)		CD67. C2878	
Cleria Publica	278 675	9	3	I	200	25.5	22.02	20,73
Earthust-cut	- W E. E.	~	14,713,880	I	267,30	37	=	13,620,472
Earthmort-fill	134,880 km	•	46,50	I	115,630	37		18, 45
Chil Bres	S, 764, 600 tery	~	17,280,000	I	4, 250, 680	75	Ħ	16, 881, 280
(40 = 60) lu	F, 460 m, ft	8	10 S	• •	8 6 E		•	20 '83 1
Paramet Brown, Traitor (F.H. 1878 of)	2 1	g R		• •			•	
8	£	5	8	•	96		•	8
Heal rests sits i	31,550 m	8	1,578,600	I	•	3150	1,420,000	1, 42, 63
Burface Malar Central								
1	40° 40° 41°	•	R.	Į.	• ;	3	2,2	2
Lacture evaporation pand (200's 200's 3")	8 Z 	1 4 5 6 6 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	4 6 6	• •	\$ 5. 8 6.	8	•	1 €
Mexitoring thills	8 0	30	9	•	ĕ	3	•	19,00
				•		•		3
		5		•			•	
Call Construction (1,590,000 sy call)	14.67 **	5,571,386	3,446,944	7	14, 662, 211	2.73	11,72,63	St, 101, 916
		•						
			8, 28, 13 3					23,38,50
Engineering design, plans and spec's lift of total costs)	* total costs)		9,538,015		9,538,015			9,530,015
Contingency ford (15% of total conta)			14,555,082		14, 255, 622			14,575,622
			A1 21 2110		M CA			0112 Et 20

 ⁻ Construction costs eccur at years and.
 - Initial construction costs are considered to be expenditures eccurred during the first 12 annths of operation (years 0 - 1).
 - Dead on a 4% discount rate (interest rate - inflation rate)

TREE & Orbation are addressed coors 817E i

	CUBITS	MAINTENACE COSTS	TOTAL 000 1987 (6)	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	TOTAL COST	MENBIT -++ NORTH FREYDR	
thate transportation cost (Table 4)	•			2.5	22,638,314		19,578,385
but hypranian	**	•	\$	25	98 '98	2	30,16
Supert Delitings that Stainment Absinistration Personnel Beson/class Trailors	4 H	88	98 % 98 %	50 50	12,300	11	2
Ned Access fleets	•	20,000	8	•	100,000	ì	5
Serface lister Central System	•	8	8	•	1	4	2
Sapling andioring solls insertarly!	45 88 1	•	A.	**	8	1	8
Abeintative for Arransal							•
3-filts Benger	80 W	•	8	5 7	275, 600	3	24. E6
	2	•	\$5,88	•	18.00 00,00	234	17.00
	4	•	\$5,00	2.5	157, 500	2	12,30
		•	\$	•	MA, 880	1.63	M. 78
		•	120,000	n	3	ì	53,75
C-theith & Pefet, serensi		•	9 9	S	672,	2°,	¥7,4
+field entimering security	N. S.	• 1		S (672,600	2	¥7.4
P-Brale farms tertade con		•		n (.	2	
- Property		•	B A	5 d	. K.	3	142,550
P-merutana.			150	*	3	Ş	£ g
		•	\$	•	8	Ì	17,00
-					PE, 481, 814	1 2	2 2
•					•		

Death occur at years and
 Beard on a 4s discount rule (interest rule-inflation)

NULE 3 CLORAGE COSTS SITE 1

		į			MENDAT-44	
	TIME		5	ENEMETINE	FACTOR	
Dayort Delidings And Equipment Decen. Foresment Trailers	*	88 %	\$ 5	52	4.67	13,075
Decemberation to the State Complete State of the State of	7. 2.	~ ~	¥4 38	5 5 1 1 2 2	**	3 %
Burface Maker Cantrol Mitch (Becom) Pand (Basere)	¥ -	- 8	¥.	# # # #	22.	83
	-	TOTAL.	01.39, 380	•	•	915,712

THE 4 FRET CLIBACE COSTS SITE 1

E		CHEST CORTS		VEND •		MEDITION AND AND AND AND AND AND AND AND AND AN	
Supert Beliefungs fort Equipment Anninistration Deliefung	1,86	8	85,1	R	8,8	14.812	21,338
Surface Hater Cambrel System Ditch	•	1,90	8 .	8	8	14.212	14,212
Statement State	8	•	**	*	135, 88	11.212	3,2
Mainistration Personal Manager (part tim) Security Board	1 2 2.		42 si	88	£ \$	14.212	25, 20 213, 18
TOTA.				•	11,45,00		873,678

s - Custs occur et years end ss - Based on a 45 discount rate (internet rate - Inflation rate)

THELE S CHEST SECTORY S YEAR BUTLAGUE STIR 1

PRESENT.	119,125,166 113,233,706	EN, 120, 250	121,712	673,078	9147.571.380 9138,551.009
190 G	113,125,166	S, 881, 814	# K.	1, fa .	0147.571.50
THEO.	Construction (Table 1)	Question I fair (Table 2) 85,001,014 84,189,239	Clause (Table 3)	Pat Clears (Table 4)	THE.

^{. -} Besed on a 4% discount rate (interest rate - inflation rate)

COST ESTINANT FOR 5-YEAR BUBLIOUT ON PHINDAY SITE
P-ESL CONCEPT
THEE MILLION COURT WAS CRIES (1639" # 1639" # 43" HIBN)
ESTIMITE IS SHEED ON THE BISHORING OF 16 MILLION CY SF MITERIAL

TABLE 1 CONSTRUCTION COSTS SITE 1

191	BLBGTTV/ UNIT	UNIT PRICE (6)	1019. COST 1967 (\$)	VERN (S) -+ CONST. CCRT OCCURS	MIT 164.40 CDET. 1967 (6)	MEXBIT -+++ NORTH FRETOR	MESON MONTH CONST. COSTS MS 1-4	CONST. CUSTS
Site Presention	\$	8	76		OC 465	831	2	3
		3 ~	120 AC 120		00 531 2 318 930			4
	1 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1) FT	1.417,220	ī		9		3,664,168
Cell Bers	3, 704, S20 bcy	. ~	11,113,560		2,778,390	3.5		10, 342, 357
		8	1	•	5	•		
Adminstration Building (40" # 60")			20.00	>	270,000		•	270,000
This day bilds (50 - 25)	. 200 . Z	8	150.000		150,000	- 8	•	150,000
Samling lateratory (20' n 20')	400 se. ft	S	90,000		90,000	1.00	•	30,080
Heal roads site 1	27,840 ft	8	1,332,000	I	•	3.630	1,263,240	1,353,240
Surface Mater Control	5 SK 14	4	× ×	1	•	63	240.54	240.557
Paralist Bras (2001, 2001, 150)		40.000	90 0		40,000	99.		
Leachake evaporation pord (200°s 200°s 9)	3	110,000	110,000	•	110,000	1.90	•	110,000
Monitoring Wells	2 10	2,000	10,000	•	10,000	1.00	•	10,000
Security Fence	21,360 19	R	427,280	•	427,200	1.0	•	427,200
Cell Construction (3,000,000 cy cell) (1,004,000 cy cell)	2 Z	15,638,305	74,491,525 5,636,399	9 4 1 5	19,622,681	2.775 6.072	54,451,455 4,914,351	74,076,377
9.6 TOTAL*		. •	9115,825,990	•	105 'SW 233			9108, SJS, 791
Engineering design, plans and spec's (10% of total costs)	f total costs)		11, 382, 530		11,982,990			11,582,550
Contingency fund (13% of tokal costs)			17,373,865		17, 373, 865			17, 373, 885
- 1-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-			SI 44, 782, 375		657, 002, 406			1137,452,254

Construction costs accur at years and.
 Initial construction costs are considered to be exercitives occurred during the first 12 months of oscietion (years 0 = 1).
 Beack on a 45 discount rate (Interest rate = inflation rate)

TRBLE 2 CPENNITION AND MAINTENANCE COSTS SITE 1

			ATOTA.			# UGSaw	PRESENT
E E	WPENNT 10N	EPERATION NATATEMENTE COSTS COSTS	1967 (S)	YEARS-4 OF DAM	1018. COST	MORTH FACTOR	
thate transportation cost (Table 4)	-		,	3.5	3.5 22,030,314		19, 976, 226
Dest Supervesion	90,000	•	80,000	3.5	38 6, 900	288.	228, 160
Supert Buildings And Equipment Againstration Personnel Decembers Trailors	, 1000 1000 1000	88	4, 10 80 80 80 80 80 80 80 80 80 80 80 80 80	en en	12, 50 6 27, 500	3 3	11, 130 24, 486
Ibel Access floats	•	20,000	20,000	10	100,000	*	93,040
Surface libtur Centrol System	•	2,000	900°5	•	13.	4	0% % %
Sealing senitoring sells (quarterly)	\$,000	•	\$ 080	.	ĸ	3	22,22
Abinistration Personal	98,080	•	15	•	275,000	3	9 8
1-Cell construction formen	\$5,000	•	\$	•	180,000	7630	13 20 20
1-Heste plecement forests	\$5,080 86,080		\$. 8 8 8	හ ∢ ෆ්	157, 900	2 2 2 3 3 4	<u>15</u> 26
	120,000		120,000	· •••	909	3	524,240
6-UVIC services)	12,000	•	172,000	3.5	672,000	22.7	47, SEA
-	150,000	•	152,080	3.5	672,000	2. 65 2	£7, 8£
4-Field anginoming samont	140,000	•	140,000	3.5	490,000	2. 8 %	33,250
	98,98	•	30,000	3.5	175,000	2, 652	142, 600
4-Security	120,000	•	120,000	'n	600,000	A. 452	534.246
2-secretarys	90,00	•	900,04	N)	200, 000	452	178, 080
TOTAL					110'100'50		REA, 120, SEO

THENE 3 Clobure costs Site 1

184	AT ELECTRICAL	UM17 CODST	1011A.	YEAR→ OF EXPENDITURE	PRESENT-66 MURTN FRETOR	MESSIT
Supert buildings had Equipment Bacon, Personnel Trailors	n	S, 000	15,000	3.5	0.072	13,079
Decentaginate Heal Reads Longitudinal roads on sibe 1 Section roads	13,920	m m	45, 750 45, 880	ស ស ស ស	0. 6 72 0. 6 72	38, 415 39, 240
Berface Water Control Bitch (Beron) Pord (Nemove)	34,800	5,000	17,400	80 85 ri ri	0.872 0.872	15, 173
	=	TOTAL =	\$124, 160		'	1108,266

TABLE 4 Post algune chists stre 1

1100	COSTS COSTS	CHENATION MAINTENMACE COSTS COSTS	107.A.	Y£986.4 OF 04H	1011 068	MESBIT-46 MORTH FACTOR	MENDIN MENTIN OF OTH OTH OTH OTH OTH OTH OTH OTH OTH OTH
Suport buildings And Equipment Administration building	1,000	95	1,990	A	45,000	14.212	21,316
Serface lister Central Byston Bitch	•	1,000	1,000	8	39,60	14.212	14,212
Monitoring Wells	\$,000	•	\$ 000	8	130,000	14.212	71,060
Melnistration Merumel Houger (set time) Security Buard	10 80 80 80 80		23, 38, 25, 300, 2,1	88	730, 656 450, 000	14.212	21, 20 21, 10
107A.•				•	11, 425,080		\$73,070

^{• -} Costs occur at years and se - Based on a 45 discount rate (Interest rate - Inflation rate)

THREE S COST SUPPORTY S VENR BUILDOUT SITE 1

COSTS PRESBIT—205TS PRESBIT—205TS PRESBIT—205TS PRESBIT—205TS 137,492,265 Deretion (Table 1) 144,782,375 137,492,266 Deretion (Table 2) 25,881,814 24,120,520 Deat Cleaner (Table 3) 124,160 134,160 675,070	CONST. CHESTS PRESBIT—4 1987 (4) MOTTH 114, 782, 375 137, 492, 286 26, 881, 814 24, 120, 520 124, 160 184, 266 1, 425, 000 675, 070	MESSOT → 40MTM 37,49c,246 Ph,120,520 188,246
--	--	---

^{4 -} Based on a 46 discount rate (Interest rate - Inflation rate)

16 YEAR BUNLARIF FERIOD - B CINCEPT RESIGN - 230 THOUSING CLOIC WITH CELLS

Bucky Newthale Avenal - MET SISE,784 THEK ET Busho Bevicts Inc. Estimate of Mate Transportation Code for a 10 Year Belifort Perind

limbs transportation costs are estimated in two partes. Heal costs (Table 2) and Leading/anloading costs (Table 3). Heats fransportation Costs to nites 1 and 6 (Demostion of tables 2 and 3) are presented in Table 4. The first and last years of the buildook paried are used for facility construction and closure, respectively. Leading/wileading codes are medican throughout the buildook paried.
Equipment production rates are based on 30 ainste hours (GM officiancy).
Equipment production rates were estimated from the 12ml, of the Exterpillar Performance Handbook.

Equipment production rates were entimated from the libel, of the Caterpiller Performance Handbook. Equipment costs are based on an harely restal for that includes overhand for a driver,a sechemic, fuel, uninformance and upone parts. Applied costs include a discount for both a volume fleet and long term restal agreement.

Equipment rental coats were previous by 130000 Constructors Inc.

HELL COSTS

thei costs are considered to be costs esaccisted with the transportation of waste from the contamination site to the land disposal facility. Table I provides an estimate of the float size and time required to transport worke from sections to disposal sites I & E. Haul distances were assumed from the camber of "sections" to the cambroid of the disposal site via the emisting read gride. lists volume in medians were taken from the SME or the Mass I Contamination Accomment Asperts of available. A summary of heat costs by sections are presented in table 1 for both sites 1 and &.. The arrest Tent coats" for transportation of waste autorial is presented in table 2. New! costs depart on heel distances and thus vary over the buildook period. thate exterial is transported in and dump hast trucks (off-road size). Heal costs are convisted individually for sections.

Equipment Specification

End dump hand truck (Caterpiller 7652, p. 256)

. 70,00016 or 25 term . 20.8 cy (street) Empty vahicle weight (EM)= 64,0001b Gross vahicle weight (EM)=131,0001b

Estimation of hasi track production rotes

that truck production rates are a function of the travel time to and from the contamination site and land dispusal facility. The total round trip trevel time is the ene of the heal time, return time and lead/onlead time.
The heal times and return times can be estimated by equations I and 2 derived frue the Caterpillar Mandach (p.233-236).
The lead/onlead time is an exemend constant. were I is in fact, based on the GMS and a total resistance of 45 (EX rolling + EX grade) Eq. (1) Heal time (min) = 0.22 + 4.016-4(17) (2) Return time faints 4.2% + 2.30E-4(2) nave I is in fact, based on the EW and 46 total resistance (24 rolling and -25 graft)

light parameters for colonistion of Table 1 and 2.

thate placement years 6
Construction days per years
Bugin made placement at and of year 1
Load/unload time (estendon) 2.15
New-ly 75% rental fee (8): 64.79
New-ly 75% rental fee (8): 64.79
New-ly 75% rental fee (8): 1,664,500

MALE I Ampaired floot size for Transportation of marko to situs 1 and 6

	_	ħ	F		ž	£	3	Ę	Ę	Ę	Ē	£	£	Ħ	\$	Ñ	5	¥	2	ŧ
CLERK OF STATE 1 BR (-	**	_	~	~	.	-	_	_	_	.	_	_	-					#
RET SIE	=	2	2	2	2	=	=	2	2	^	9 7	~	n	2	2	2	2	=	2	
PLET SIR F	•	_	=	2	•	•	•	=	2	=	2	=	2	2	*	*	±	*	2	
MATERIAL PROPERTY OF SUITE 6	57.17	17.12	3	45.01	3.2	2.8	57.17	7.E	7.12	S &	18.3	18.4	E X	3.5	7.2	4	H. 65	3.K	E1.16	
SITE 1	17.6	107.57	27.53	27.2	22.5	4	2	2.8	= 3	71.77	3 d	72.73	3 .3	£.:	21.67	3 .8	3	2.3	8 4	
TOTAL THE SITE 6	16.15	¥.:	2	Z	E.3	7	IF 13	#.:	¥.::	1.67	2	1.67	1	11.9	1.9	E E	3.2	7.C	11 12	
1018. 1016. 1716. 11 SITE 18	\$ 15	3	17.66	13.66	スプ	3	3,4	20.33	17.07	12.17	17.11	2.3	17.10	H	17.87	1. Y	25	17.9	# · ·	
FE (2000) 11 2016 6	3,	3.13	2,4	111	3.12	2	3,	713	3.13	2	A :	 8	R :1	31.15	3.18	K	7.8	7.8	2.2	
THE (MIN) TO SITE 10	- 8	8.3	7.67	3.67	6.71	2.3	2	7	2	4	23	1.37	23	£.3	*	F.	Ŋ	£3	2.0	
TINE CHINO TI BITE 6	2	2	¥.'.	10. E	K	7	2	2	24	No.	2	2	20	r.	ri K	1 00	17.18	17.40	7	
MAC. THE CHING T SITE 18	1.3	14	3	3	12.1	4.27	127	2	2	23	F. 67	27	1.0	=:0	H	N	8	N.	3.5	
DISTRICT TO SITE 6	3	1	15.00	5	1.88	7.5	3	38	38.	2	2,	25	2,	1	24	20	27.72	27.48	37,960	
MAL District Site 15	1	7	12.70	271	2.7	4	3	12,660	17.30	12.710	17.78	12,30	- 1. - 1.	2 ×	7	1	7	7	*	
	198.00	16.10.70	2.165.000	1,715,500	17, 180	12,900	3	8	8	52.53	2	169,000	- T	147.000	2.6	2	20 13	47,800	98 1	
1 1 1 1 1 1 1 1 1 1		Ħ	;	•	10	19	Z	2	2	Я	2	Ħ	M	1	•	2	=	~	•	1
	-	• •	•	•	•	•	~	•	•		=	3	2	±	•	#	=	.	2	

SO VERN BUILDING PERIOD - D CHACEPT REBITM - 220 INCLUME CLBIC WITH CELLS

1		=
MESSON ACORTH SITE 6	1, 286, 1 1, 28, 1 1, 26, 1 2, 26, 26, 26, 26, 26, 26, 26, 26, 26, 2	113,085,13
MENBIT MOTH SATE 1	61, 34 39, 98 39, 98 11, 91 11, 131 11, 191, 193 11, 194, 193 11, 194, 193 11, 194, 193 11, 194, 193 11, 194, 193 194 194 194 194 194 194 194 194 194 194	16, 356, 500
PRESENT ADMIN FRETOR	CANAGE CA	•
1967 COST SITE 6	- Marian - M	115,609,973
# 6 # E	**************************************	110, 273, 041
\$		

LONG/ANLOND COSTS

Lead costs are costs semeciated with placement of weste in heal trucks.

Ebland costs are costs associated with placement and compaction of the weste at the land disposal facility.

Lead costs are beaud on a docer to windrow weste autorial and a loader to place the weste in a heal truck.

Placement costs are beaud on a docer and motor grader to move, level and compact the meterial at the land disposal facility.

Lead/whicad costs are proportional to the weste placement rote and therefore are oniform.

A memory of annual load/whicad costs are presented in table 3.

Equipment Specifications

<u> </u>	85. 87.	65 82 82
Bocse (Caterpiller 89, p. 15)	Loader (Caterpillar 900, p.200;	Noter Oraber (Caterpiller 148, p.75)
BAN(16)*	GAN(15)=	GW(1b)=
Flydwel poser (hg)*	Flydwal power Ap)=	Flyshed pamer (hp)=
Universal blade	Buchet size (cy)=	Randerd 14' blade

THEE 3 AND LESS AND COSTS -

٥	MEDILY MEDIL BUTE (MCY)	HOLLY HOLL (4)	1	MENTAL (6)	VENEZ OPERATION	1900 (6) 790	FICTOR P	
~	- ·		8	412,006	I	3,236,651	£.733	2,774,639
~	\$		F	316, 223	I	2,346,386	£.73	E, 143, 270
-	4		2	25.22	I	120,027	£.73	EH, 153
			ı	86N, 056	•	66, 572, 768	•	65, 540, 628

^{• -} Lead/whood costs are the same for sites 1 and 6 • • - Beard on 8 hour days 350 days par year

10 YEAR BUILDUST PERIOD - D CONCEPT PERION - 250 INCLINUS CADIC YARD CELLS

THREE 4
METE THRESPORTATION COSTS
FOR
FOR
SITES 1 FM 6

EIFEOTURE	E S S S S S S S S S S S S S S S S S S S	SITE 1 PRESENT ADMIN	SITE 6 COSTS 1987 (6)	MESSENT LEGITH
WILL COSTS (THRLE 2)	10, 273, 041	A, 255, 500	15,635,973 13,065,15	13,065,151
LOWANGO (TRLE 3)-	7,911,32	6, 658, 366	7,911,320	6,638,386

+ - A CHPERITOR FICTOR HAS BEEN ABEEN FOR LEVEL & LIGHER PROTECTION

914,164,362 914,985,256 823,571,295 919,743,517

TOTAL -

CHIT GETUNNE FOR 18-1678 BATLABAT OR PRIVATE ST.E.
B-CELL CHICEFT
259 PROJECTO CLÓSE WARD CELLS (GLEV » 6.35° » 4.2° MER!)
ESTIMATE 15 SMED ON THE DEPOTOR, OF 16 MILLION CY OF WATERING.

THRE 1 CHARTALCTION CARTS SITE 1

10.	SUBSTITY/ UST	WIT (9)	101A. CDS1 1987 (6)	VENEUS) -+ CENET. COST (CCURS)	CDGT. 1987 (4)	MEDENT -+++ MONTH FROTON	MESSAT MATTER ME 1-7	MESBAT MOTH COST. COSTS VAS 0-7
Site Propertion Clearing Bribbing Earthwart-cut Earthwart-1111 Call Bows	(1) 26, 600 to 10	999	65K, 608 3, 531, 40 11, 000, 180 30, 180	1111	51 25. 9 51 25. 9 51 25. 9 51 25. 9	2222	2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2	4 795, 44 4 795, 16 5 785, 16
Support Buildings and Equipment Association building (40° x 60°) Aurasmal Burm. Trailor (60° x 20°) Rainformers Building (60° x 20°) Susping interretory (60° x 20°)	t : : : : : : : : : : : : : : : : : : :	* * * * * * * * * * * * * * * * * * * *	27.00 27.00 20.00 20.00 20.00	••••	42. 62.48. 68.48. 68.48.	8888	••••	4 5 4 4 8 8 8 8
Heal reads miles 1	51,000 A	8	4,638,400	ı	•	25.5	4,062,330	4,062,330
Surface Union Cambral Bitch Setantion Pand (850°s 650°s (5°) Lacthale overpretion poed (800°s 500°s 5)	117,280 m	46, 486	¥ 4 € E	1	4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	7	\$ ° •	8 4 2 8
Mentitering thills	8 00	2,000	5.	•	16,00	1.8	•	<u>.</u>
Security Fonto	71.00.17	8	%, <u>\$</u>	•	542, 408	<u>.</u>	•	542,400
Call Construction (259,400 cy call)	3	1,673,490	1,672,490 167,162,360 0	r -	5,095,023 0	a K	07,853,662 •	N, 26, 65
		. •	165, 155, 380	•	62, 643, 33			1132, 284, 635
Engineering design, plans and specie (166 of total costs)	total costs)		16, 915, 528		16, 915, 238			16, 915, 938
Destingency ford (15% of total conts)		•	2,373,337	•	2,37,50		·	A, 171, 527
- 10401		•	P11,445,475		664, 652, 839		-	138,574,351

 ⁻ Enwirection cods eccur at years and.
 - Initial construction cods are considered to be expenditures occurred during the first 12 months of operation (years 0 - 1).
 - Beand on a 4% discount rate (interest rate - inflation rate)

MALE & Creating and Adjunctions (1967) Site 1

e		OFENITOR INJUREDUCE COSTS COSTS	1978. 1967 (8)			MONTH FACTOR	
hate transportation cost (Table 4)				-	23,438,577		19,424,176
bet Specales	8,8	•	8 8	•	610,000	F.78	538, CE
Agent Delibings And Equipment Abstraction Procured Decorptions Trailors	24	88	2, 30 000 A	22	41 H		89,23 44,611
bul Acces fleats	•	20,000	38,000	2	200,000	==	162,220
beface these Control Byston	•	98 si	8	2	8	=	R
bepling andtering sells teactorly)	S, 000	•	A. 88	2	8 , 8 ,	FI	8
Mainistration Personal		•		2	8		* 8
i-Cell construction forms	45, 880	•	\$ 90		465,000	7.48	33,573
1-thate placement formers	4 4 8 8		4 4 8 8		86,000 86,000		
Publication	98	•	8	. =	600,000	F 111	3
	96 A	•	3 6	•	74,000	2	H.
Deficie and services				•		3 2	
1-Brate bouse technicies	2	•	8	•	200,000	£3	164,355
2-facetty	38,33	•	98,	2	900,000	=	3,4
1-secretary	20, 600	•	60 82	2	200,002	F :::	16,250
TOTAL					429, 894, 577		et, 757, 185

o - Coats accur at years and so - Beaut on a 4% discount rate (interest rate-in/lation)

THULE S CHET BANNEY 10 YEAR BUILDON SITE 1

一直自じる だ	•	₹	3
MERBAT MERTAN 194,574,35 24,757,18	203, 310	186, 443	KER, OS.
CONT. CURTS PRESENT- 1987 (4) MORTH E11,445,473 194,574,281	£3,28	1,45,00	241, 647, 272 6254, 661, 489
ຣ		\$ • \$	•
COURTS PRESENT— COURTS PRESENT— COURTS 1987 (6) MERTIN Construction (Table 1) 211,445,473 194,574,251 Operation 1 Shin, (Table 2) 25,694,577 24,757,165	Closers (Table 2)	Aust Closure (Table 4)	

officed on a 46 discount rate (Interest rate - Inflation rate)

COST ESTIMATE PER 10-15TH BALLANT ON PRIVATE SITE.
9-CBL CINCEST
GE HILLION COST, WIG CRLIS (1004 ± 1004 ± 42° 1000)
ESTIMATE 19 PARES ON THE STREAM, BF 16 HILLION CY OF WITHING.

MBLE 1 COGNICTION COOR SITE 1

	SERVITY/ MAT			COST COST	MTM. 46 CMST. 1987 (8)	METER - +++ METER FICTURE	COURT. COURT	COST. COST
Site Argentian Libering Bribling Enthert-ret Enthert-fill Call Bres	19 19 19 19 19 19 19 19 19 19 19 19 19 1	1777	4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	ııı	2. 2. 2. 2. 2. 2. 2. 2. 2. 2.	zzzz zzzz	7,607,1 1,807,1 1,811,1 10,100,1	45, 45, 45, 45, 45, 45, 45, 45, 45, 45,
Amount buildings and England Aministration building (40° = 40°) Amount Dece., Irailor (9° = 20°) Asistomere Building (40° = 20°) Empling Labordory (40° = 20°)	e e f::f ??!?	* * * * * *	25 E &	••••	4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	\$ \$ \$ \$ \$	••••	4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4
that reads site 1	£ 32,4	8	2, 88, 988	I	•	3	1,771,78	1,711,78
Serfess Saler Control Bitch Belowline Peat (889°s 889°s 15") Lasthole enquestion peat (809°s 809°s 5")	20,20 21 22 21 23 22 22	46, 000 110, 000	M 4 4 6 6 6 11	!••	46, 86	X 3 3	H, TH	H 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4
Sentering Sells		2,000	19,0	•	10,000		•	4
Scurity Force	22, 200 11	8	***	•	# · #	1.8	•	**
Call Construction (1,000,000 cy cell)	#	5,656,339	SP, 165, 384	I	1, 095, 023	ğ	72,159,434	11, 23, 45
8.0 WILL.		•	6119, 3K, 636		ets, 525, 710			9107,677,EDA
Engineering design, plans and aper's (166 of total costs)	f total conts)		11,520,66		11,538,666			11,530,666
Contingency ford (156 of total conto)		•	17, 997, 998		17,907,998			17,907,930
Total •		•	114,223,300		#5, 88, 174			617, 12, 68

 ⁻ Dandruction code occur of yours and.
 - Initial condruction code are considered to be expenditures occurred during the first 12 menths of operation (yours 0 - 11.
 - Dand on a 46 discount rate linkwant rate - inflation rate)

THULE & OFFICE COSTS SATE 1

Speciment Committee Comm				Ē				
	2			1907 (S)			FACTER	5
4,000 - 4,000 13.39 - 2,000 300 2,300 20 114,000 13.39 - 3,000 3,000 20 13.39 - 3,000 3,000 20 13.39 - 3,000 3,000 20 13.39 - 3,000 3,000 20 13.39 - 3,000 3,000 20 13.39 - 3,000 2 2,300 20 13.39 - 3,000 2 3,000 20 13.39 - 3,000 2 3,000 13.39 - 3,000 2 3,000 13.39 - 3,000 2 3,000 13.39 - 3,000 2 3,000 13.39 - 3,000 2 3,000 13.39 - 3,000 2 3,000 13.39 - 3,000 2 3,000 13.39 - 3,000 2 3,000 13.39 - 3,000 2 3,000 13.39 - 3,000 2 3,000 13.39 - 3,000 2 3,000 13.39 - 3,000 2 3,000 13.39 - 3,000 2 3,000 13.39 - 3,000 2 3,000 13.39 - 3,000 2 3,000 13.39 -	11				=	CZ, 189, 229	•	10,006,922
Part	bat Appresia	**	٠	\$	=	720,000	1 5	3, 3
13.79		9 4 4	* *	8 8 3 4	2 2	30,000 110,000	673	u E
femantarity 5,000 - 5,000 E8 160,000 13.39 St,000 - 5,000 E8 1,100,000 13.39 St,000 - 5,000 E8 1,100,000 13.39 St,000 - 5,000 E8 1,200,000 13.39 E0,000 - 5,000 E8 1,200,000 13.39	Ned /Person fleets	•	28,000	38,08	*	400,000	11.39	271,880
13.99 14.000 15.0000 15.0000 15.0000 15.0000 15.0000 15.0000 15.0000 15.00000 15.00000 15.00000 15.00000 15.00000	Serfes taker Central System	•	1 1 1 1 1 1 1 1 1 1	8	2	100,000	11.9	67,38
Section 1,100,000 1,139 1,100,000 1,139 1,100,000 1,139 1,100,000 1,139 1,100,000 1,139 1,100,000 1,139 1,130 1,139 1,130 1,139 1,130 1,139 1,130 1,139 1,	Supling antioning sells (querterly)	980-1	•	*i	2	189,080	12.9	82,73
Street S	Mainistration Personal	5	•	8	8	1.106.000	24	747,58
Section Column	- Contraction forms	98	•	3	2		¥1.41	34,63
Safety personnel	1-fa-11/tien fertien	9	•	2	2	200 'SE	*1	391,03
Safety personnel 25,000 - 25,000 16 575,000 12,629 Safety personnel 25,000 - 25,000 12,939 Safety personnel 25,000 12,000 Safety personnel 25,	Platers.	66,900	•	3	2	1, 280, 800	11.99	812, 408
Safety personnel 12,000 12,000 13,000 12,000	1-GA/E: sersone)	88	•	8	=	576, 800	12,63	#0t, 0
### 12,000 - 13,000 - 13,000 12,000 1	-theith & Sefety serverse	9	•	8	=	576,000	15.63 15.63	*
25,000 13 450,000 12,659 12,590 12,690 12,590 12,590 12,590 12,590 13,59	1-Einld eniments sessor	8	•	8	=	89.0F3	12.63	443,065
20,000 - 20,000 25 - 00,000 13.39 7 - 20,000 25 - 00,000 13.39	Labelle brase technicism		•	8	2	8 6	12.63	316, 475
7 - 25,000 - 25,000 20 - 02,000 13.59 - 02,000 13.59 - 02,000 13.59 - 02,000 13.59		3	٠	3	2	1,200,000	113	915, 400
	1-merutary	80 62	•	28,080	2	*	173	11,800
						CK, 511, 25		45, EM, 300

-Costs accur at years and
 - Desait on a 4% discount rate (interest rate-inflation)

10 YEAR BUILDING FERIED - IN CONCEPT RESIGN - ONE WILLIAM CLOSE VAND CELLS

THE E CHEMING AND HOLD REPORTE COSTS SITE I

•	OPERATION COSTS	COENTIAN INITERACE Costs costs	1911. 1967 (6)	VENEZA OF DOM	TOTAL COURT	MEMBER 44 MONTHS FRCTUR	
hate transmitation cost (Table 4)					23,438,577		19,464,176
bet Depresión	99,000	•	900 '08	•	000,000	£ 733	3 6
Deport Delidings And Squipment Administration Personal Decembers Trailors	2,000 1,000 1,000	88	98 88 2 1	22	2 K	11	82 83 119 4
Heal Agents Reads	•	20,000	20,000	~	200,000	A.111	16,20
Series tater Control System	•	g, 600 g,	8 8	-	980 '0S 01	F = 3	\$
Sauling sentering sells (querterly)	8,000	,	5,000	-	000 °SC 01	F. I.	1 1 1 1
Abinistration Personal	1		1	•	•	=======================================	AK. 165
1-5/to Navagill	ki :	• •		•			
1-Call construction former	ą. P.				MO.000		
1-thate placement forces			} {		465,000		
1-tecilities former	Į.		5	•	600,000		
Plabren			8	•	744,000		
3-GVC persone			8		74,000		
3-beith I briety personnel			Ę		MA.000		
2-field engineering engeon	\$ 1 E 1		1		900 000		
1-Brain teams technicism	8 ន						
2-Bearity		, ,	8 1 2		000,003 01		162,220
			•			1	
					FE, 55, 517		24, 757, 188

o - Cost eccur at years and on - Based on a 45 discount rate (interest rate-inflation)

CLOSUSE COSTS SITE 1

1 1	VIII	UMI T	TOTAL COST	VENT	MENENT-44 MORTH FRCTOR	MESSAR
Separt Buildings for Equipment Secon, Personal Trailors	•	S, 280	15,000	-	A.731	10, %1
Decotacionte Paul Rech Longitudinal reche en elto i Rection rech	25, 104 15, 000	~ ~	5, 20 5, 000	••	e 731	13 28 38
Burface Mater Control Sitoi (Sucon) Pord (Sucon)	3-	- 996°s	45. 44. 500 44.	••	9 9	4 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5
	_		1183, EM			81.X.

THREE 4 MUST CLUSSIFE COUTS SITE 1

2	CUSTS	CHESATION MATATERATOR CIGITS CUSTS	Ē	40 PP	Ē	MENTIN FACTOR	
Deport Delidings And Equipment Administration Deliding	000'1	8	906'1	8	45,000	11.063	25.
Surface Mater Control System Ditch	•	 88.	1,00	8	36,00	11.063	11,983
Manitoring Mells	98 s	•	**	2	138,000	11.061	Si A
Main(stretion Personal Houser (per tim) Seculty Sear	8 8 8		1 0 25	88	738,080 630,000	11.00	ETT, 015 164, 246
1011C					81, 455, 800		SER, AL

o - Caeta excer et years and se - Based on a 45 discount rate (interest rate - Inflation rate)

THERE 3 CLOSUME CUSTS SITE 1

					MORTH	MERCAT	
	QUIENT 1 TV	C08T		ш	FACTOR		
Support Delidings And Equipment Decembersonnel Trailors	m	5, 000	15,000	•	0.731	19,%	
Decontaminate New! Newto Longitudinal reads on site ! Section reads	5. z. 3. 8	m m	3. 38. 33 39. 30	••	0.731 0.731	2 N	
Burface Mater Centrol Bitch (Becon) Fond (Basove)	3 ~	- 000 st	\$5. P.S.	••	2 2 2 2	51, 20 3, 634	
	-	TOTAL	9878, 240			6203, 310	

THREE 4 MOST CLOSUME COSTS SITE 1

5	COURT	CUSTS COSTS	101E	VENES-+ OF DAM	TOTAL DEED	MESIBAT -++ ACTOR	
Suport Dildings that Equipment Abunistration Deliding	986.1	96	1,900	R	45,000	11.083	7.
Serface lister Centrol System Hitch	ı	1,000	1,80	8	80,08	:: ::	11,00
Monitoring Wells	90 %	•	a.	*		 	35,415
Stainistration Personal Hougar (pert tim) Security Guard	2 2 3 3 3 3 3		25, 60 15, 000	88	738, 088 439, 900	11.663	ETT, 073 166, 245
TOTAL.				•	91,455,000		625, 143

s - Dosts occur at years and so - Dosts occur at years and so - Based on a 4% discount rate (interest rate - E#46% (on rate)

THEE S COST SUPPRIVATION TO YER BUILDON

TT. TS PRESENT—4 (\$) NOTTH	149,223,220 137,523,698	,577 29,757,185	183,6M 134,189	1,425,000 326,443	114 TE CAL ALCO DAL 714
CONST. COSTS 1967 (8)		Table 21 23,09	ä		1 5
	Construction (Table 1)	Operation & Main. (Table 2) 29,499,577	Clears (Table 3)	Pest Closure (Table 4)	-

o - Beed on a 45 discount rate (Interest rate - Inflation rate)

IN YOR AUTURN'T RENOW - IN CONTENT RESIDN - ONE & ONE WILL WILLIAM CADIC YARD CRIES

COST ESTIMITE FOR 10-15M BUILDOUT ON PRINCENT STIE.

D-CRI. CONCEYT
OR. 1. OVE. HULF WILLIAM CUBIC, WAS CRILS (1004 % 1004 % 64" HIGH)
ESTIMITE IS MARED ON THE DISHORD, OF 16 MILLION CY OF WITHOUT.

THRE 1 CINSTRUCTION COSTS SITE 1

	SECRETARY UNIT	CHIT PRICE (8)	TOTAL COST 1967 (6)	YERRIED + CONST. COST SCOUNS	1M111AL-44 CDG7, 1987 (9)	MEXBIT - 444 MORTH FRCTOR	MERBIT MORTH CONST. CUSTS 1-7	MERBIT MORTH CONST. COSTS VIS 0-7
Uto Properation Classing Braiking		961	378, 600		2 × × × × × × × × × × × × × × × × × × ×	3.3		17.0% 17.0% 17.0% 17.0%
Earthmort-cut Earthmort-fill		3 M	62,534 62,600	[]	101,772	2 3	Z 21.	417,015
Call Brus	S, 760, 000 lery	~	17,280,000	I	3, 801, 600	y N	Ca (c) (11	(30'/C'E)
Support Delitings and Equipment	1 5	•	8	e	68,600	90.	•	20.00
After Street on Delicing (40" x 40")		8 8	20,000	• •	270,000	8	•	270, 888
Market Control of the	7.900 es	2	130,000		136,000	 86.	•	138, 600
	# 00 1	S	90,000	•	90,000	1.8	•	8
Heal reads site 1	31,560 ft	8	1, 578, 600	I	•	27.20	1,378,646	1,378,646
Surface Mater Centrol	1	•	¥	ä	•	3		2
Ditt.	= 8 -	40,000	\$ 8		4			3
Leachete eveporation pond (200° n 200° n 3°)	.	110,000	110,000	•	110,000	. 8	•	8
Manitoring Wells	2 00	2,000	16,88	•	10,000	8	•	10°
Becarity Fonce	15,680 1f	8	330,600	•	353,600	1.8	•	35,25
Call Construction (1,500,000 sy cell)	10.67	3,571,386	9,44,94	2	5,095,023	Ş	M, 631, 401	48,489,48
86 TUR.		·	95, 251, 330	1.	117,386,659	_		96, 275, 338
Engineering design, plans and upac's 110% of total conta)	f total conts)		9,535,133	_	9,538,133			4,518,121
Contingency fund (13% of total costs)			14, 380, 699	_ :	14, 308, 699			14, 382, 699
Total •			9113, 169, 162	ı	169 (14			6110, 157, 230

 ⁻ Construction costs accur at years and.
 - Initial construction costs are considered to be expenditures occurred during the first 12 months of operation fymats 0 - 13.
 - Beard on a 45 discount rate (Interest rate - inflation rate)

THE E CHESKY TON FROM THE PRINCE CLISTS SITE 1

2	COURTS COMPANY TON	COSTS COSTS	1814. 1967 (8)	VENES.	TOTAL	PREMENT ++ LONDING FRETTOR	MENENT CONTRACTOR OF THE CONTR
Made transportation cost (Table 4)			,		22,458,577	,	19,424,176
but Supression	90,00	•	98 '98		640,060		538,640
Support Delidings And Equipment Administration Personnel Deconfelson Trailors	999 '3' 900 '5'	96 96 96	2,500 5,500	2 2	8 8 8 ki	===	29,23 44,611
Heal/Access floads	•	000 '02	88	2	200,000	£111	162,220
Surface lister Centrel System	•	3,000		2	36,00	===	Ħ.
Supling southering wells (quarterly)	900 °S	•	*f	2	88'88	F III	40,385
Abinistration Personnel	1	ı	Š.	7			*
l-6ite Manger					405,000	9.	2
TANK CONCINCTION TOTAL	90 \$4	•	95	•	360,000	£.73	
Lengthing forms	9	•	37	•	405,000	2.68	
	9	•	99	=	000'009	6. 111	
3-60/05 partitions	%	•	36,98	•	764,000	£73	
	8	•	% 80 %	•	764,000	6.73	
2-Field ansingering materi	25.00	•	20,000	•	360, 600	£ 75	
1-Pale forme terbairies	8	•	8	_	200,000	213	
2-Germitte	66.99	•	99	2		£ 121	
1-secretary	900'02	•	20,000	=	200,000	F	92,291
TOTAL					4ES, 854, 577		ee, 757, 165

 ⁻ Costs occur at years and
 - Dead on a 45 discount rate (interest rate - infliation rate)

THRLE 3 CLOBURE COSTS SITE 1

				188	PEBU-	
	CEPTETY	UNIT	TOTAL COST	OF EXPENDITURE	FACTOR	MERBIT
Supert Paidings And Equipment Secon. Arnormal Trailors	m	5,000	15,000	-	0.731	10,961
Decontaminate Heal Roads Longitudinal roads on site 1 Section roads	16, 900 15, 000	m m	8 8 9 9 9 9	● ●	0.731 0.731	***************************************
Surface likter Centrol Bitch (Bucon) Pond (Masove)	98° 94	5,000	20, 130 3, 000	•	0.731 0.731	14,724
			91.25, 330	• -		940,046

TWILE 4
FUET CLOBUTE COSTS
SITE 1

	OPERATION COSTS	OPERATION MAINTENENCE CUSTS CUSTS	1018. 084	YEME-+ OF CM	夏	MESENT ++ MUNTH FRETOR	MERDIT MOTTIN OF
Suport Buildings And Equipment Assimistration Building	1,000	8	1,300	R	45,000	11.063	ã S
Series Water Centrol System Ditch	ı	1,000	1,000	8	30,000	11.003	11,063
Monitoring Mells	3, 000	•	3° 000	8	130,600	11.00	a, a,
Absinistration Personnel Navager (part tim) Security Beard	25,000 20,000	1 1	\$2 98 98 98	88	738, 080 438, 000	:: :: :: ::	277,075 164, 245
101A.					11, 425, 000		585, AS

o - Cast accurs at years and so - Besed on a 4% discount rate (Interest rate - Inflation rate)

THRLE S COST SUPPORTY 10 YEAR BUILDOUT SITE I

2,00	COUNTY. COUNTS (987 (8)	MENBATT-4 MONTH
Construction (Table 1)	119, 169, 162	119, 169, 162 110, 197, 230
Operation & Main, (Table 2) 29,894,577	25,694,577	24,757,165
Closure (Table 3)	135,330	99,046
Post Closure (Table 4)	1,425,000	226, 443
	6130, 644, 285 0135, 579, 904	578.904

^{. -} Based on a 4% discount rate (interest rate - Inflation rate)

CORT ESTIMATE PUR 10-YEAR BAILDOUT ON PRINKING SITE

P-COL. CONCEPT
THE MILLION CIBIC YOUR COLLS (1639" x 1639" x 43" HIBM)
ESTIMATE WILLION CIBIC YOUR EDISTORAL OF 16 MILLION CY OF MATERIAL

TMBLE 1 CONSTRUCTION COBTS SITE 1

191	פנושונון, עונו	UNIT PRICE (S)	1987 (8)	YEAR(S)→ CDAGT. CUST CCCARS	INITIAL-++ CONST. 1987 (8)	MESERT -+++ LOTTH FRCTOR	MORTH MORTH COMET, CORTS COMET, CORTS VISS 1-7 VISS 0-7	MOTHN CORET. CORTS VRS 0-7
Site Properation		900	456,000		109,236	35.2k		
Sathant-Cut	_	~	13,275,720	I	2, 920, 638		3,046,672	11,967,531
Statement (S. 1)	1.312.440 127	~	3, 937, 220		866, 210			
Call Bres	3, 704, 520 lesy	F73	11,113,360		2,444,983			
Support Paildings and Equipment				,			•	1
Abelnistration Dillaing (40" x 60")	2,400 m. ft	8	25. SE	•			P (
Personnel Becen. Trailer (6'n 12'n 40')	2 i	g s		∍ <			• •	98 95
Naintenance Deliging (a)" x 23") Sampling laboratory (20" x 20")	# 100+	3 5	8, 80	• •	96		-	90 06
Heal roads site 1	27,840 ft	8	1, 392, 006	I	•	3.24	1,214,144	1,216,144
Surface Hater Control	\$ \$		86 13	1	•	36	231.673	23,63
Distriction of the contract of		90.00	96		6.00			
Leachate evaporation port (200° x 200° x 5°)		110,000	110,000		110,000		•	110,000
Manitoring Wells	2 0	2,000	19,000	•	10,000	1.98	•	10,000
Security Fence	21,350 19	2	427,200	•	427,200	1.00	•	£/,4.1
Call Construction (3,000,000 sy cell) (1,000,000 sy cell)	# # # # #	15,658,305 5,636,599	74,491,283 5,624,599	Ţ	3,095,023	y R	61,787,084 4,454,604	70, 885, 107
Sub total.			115,825,900	• _	816,657,37 1			6103, 988, 873
Engineering design, plans and specie (10% of total costs)	f total costs)		11,382,550		=,36,38			11,382,330
Contingency fund (156 of total costs)			17, 373, 865		17, 373, 865			11,373,005
* ****			6144, 782, 375	٠	MS, 613, 9M6	ì		9132, 945, 348

Construction costs occur at years and.
 Initial construction costs are considered to be expenditures occurred during the first 12 months of operation (years 0 - 1).

MULE & CHEMING HOW WAINTENNESS CUSTS SITE 1

14 YEAR BUILDON PERIOD - D CONCEPT BESIEN - TWEE MILLION CLOIC YARD CELLS

2	CUESTAT TON	CUSTS COSTS	1914. 187 (8)	YES P	TENE COST	PRESENT 44 MORTH FRCTOR	MOTH ON
Whate transportation cost (Table 4)				•	E, 458,577		19,454,176
bet Supresion	900 '08	•	90,000	•	640,000	£ 73	53,52
Supert Stillings And Equipment Radinistration Personnel Decorcion Trailors	900 4 H	88	00 o 3 s	9 9	11 15	==	20,278 44,611
Heal /Recess Roads	•	20,000	86,680	2	800,000	£.111	82'3I
Surface Mater Control System	•	3,000	\$ 900	2	30,000	=======================================	PR S
Sampling scuttering sells (quarterly)	S, 900	•	\$ 900	2	90,00		8 , 48
Abinistration Personal	*		8	2	89 97	Ξ	44. 16
		•	900		465,000	7.68	
	98 5	•	9	•	350,000	£ 733	326,355
Lend libite forms	\$ 900	•	45,000	•	405,000	7.458	
24 shares	900	•	60,000	9	900,009	£.111	
2.00.00 mmmmm		,	90	•	766,000	£ 733	
Table of Safety annual		•	900		768,000	6.733	646,348
design of property of the party of	900.00	•	20.00	•	360,000	6.733	
	1 0	•	8				
	9	•	60.00	2			
1-perietary	20,000	•	20,000	2		6. 111	
					129,894,577		PEN, 757, 165

- Deats occur at years and
 - Bead on a 4% discount rate (Interest rate-inflation)

THRLE 3 CLOSURE COSTS SITE 1

			İ	AESS.	PRESENT -++	
	QUANTITY	COST	101 PE	EIPEDOITURE	FACTOR	HIDN:
Support Buildings And Equipment Decen. Personnel Trailors	3	\$,000	15,000	•	0.731	10,961
Decentualiste Heal Reads Longitudinal reads on eite 1 Section reads	13,920 15,000	mm	41,760	• •	0, 731 0, 731	380 '22 '22 '23
Surface Mater Centrol Ditch (Becon) Fond (Basove)	41,750	1,000 pt	89 % 800 %	•••	0.731 0.731	15,257 3,634
	•	TUTAL	9127,640		•	193,267

TABLE 4 Post closure costs Site 1

1911	OPENATION COSTS	OPENATION MAINTENANCE COSTS CASTS	100 100 100 100 100 100 100 100 100 100	VONG +	E 8	MORTH FACTOR	LOUTH OF
Support Duildings And Equipment Amenistration Duilding	000'1	8	96,1	R	\$5,000	11.063	16,62
Surface Mater Control Bystes Pitch	•	1,000	1,000	R	30,000	11.063	11,063
Honitoring Wells	\$,000	•	s, 900 1,	8	130,000	11.063	Ř
Absinistration Personnel Menager (part time) Security Bland	8 8 8		4) 21 88 88	88	130,000 000,000	11.063	277,075 166,245
וסות.				'	11, 425,000		100K, 443

6 - Costs accer at years and 80 - Beesd on a 45 discount rate (interest rate - inflation rate)

THERE S
COST BUSINEY
10 YEAR BUILDOUT
SITE 1

CONST. COSTS PRESENT— 1907 (6) MORTH	144,782,375 132,945,348	29,894,577 24,757,165	127,640 93,267	1,425,000 526,443	6176, 229, 592 4158, 322, 242
CUSTS	Construction (Table 1)	Operation 6 Nain, (Table 2) 25,654,577	Closure (Table 3)	Post Closure (Table 4)	TOTAL

^{. -} Beard on a 4% discount rate (Interest rate - inflation rate)

Rocky Hountain Arsenal - USST 5658, 784 TRSK 27

Ebasco Services Inc.

Estimate of Maste Transportation Costs for a 20 Year Buildout Period

Moters

Maste transportation costs are estimated in two parts: Haul costs (Table 2) and Loading/unloading costs (Table 3). Maste Transportation Costs to sites 1 and 6 (Sumation of tables 2 and 3) are presented in Table 4.

The first and last years of the buildout period are used for facility construction and closure, respectively, Loading/unloading costs are uniform throughout the buildout period.

Equipment production rates are based on 50 aimste hours (836 efficiency).

Equipment costs are based on an hourly rental fee that includes overhead for a driver, a mechanic, fuel, maintenance and spare parts. Equipment production rates were estimated from the 12md. of the Calerpillar Performance Handbook.

Rental costs include a discount for both a volume fleet and long term rental agreement. Equipment rental costs were provided by EMSCO Constructors Inc.

HOLL COSTS

haul costs are considered to be costs associated with the transportation of waste from the conhamination site to the land disposal facility. Mael costs are calculated individually for sections.

Table I provides an estimate of the fleet size and time required to transport waste from sections to disposal sites 1 & 6. Haw! distances were measured from the canter of "sactions" to the centroid of the disposal site via the existing road grids. Weste volume in sections were taken from the DNLF or the Phase I Contamination Accessment Reports if available.

Maul coats depand on haul distances and thus wary over the buildout period. Maste material is transported in end thum hawl trucks (off-road size).

A summery of heat costs by sections are presented in table 1 for both sites 1 and 6.. The annual "hawl costs" for transportation of waste material is presented in table 2.

Enuipment Specifications

End dump have truck (Caterpillar 769C, p. 226)

= 70,0001b or 35 tons Empty vehicle meight (ENH)= 66,00016 Gross vehicle weight (BWs)=136,0001b

22.8 cy (struck)

Cencity

Estimation of haul truck production rates

Heal truck production rates are a ferction of the travel time to and from the contamination site and land disposal facility. The total round trup travel time is the sum of the heal time, return time and load/enload time. The haul times and retern times can be estimated by equations 1 and 2 derived from the Caterpillar Mandbook (p.233-234). The load/unload time is an assumed constant. were X is in feet, based on the GMM and a total resistance of 45 (24 rolling + 24 grade) Eq. (1) Haul time (min) = 0.22 + 4.81E-4(X)

Eq. (2) Return time (min)= 0.24 + 2.50E-4(1) mere X is in feet, based on the EW and 66 total resistance (28 rolling and -28 grade)

Input parameters for calculation of Table 1 and 2.

16 250 (5 days/meek-52 meeks/year)		2.15	たさ	740,844
Maste placement years: Construction days per years	Begin waste placement at end of year	Load/unload time (minutes)=	Hourly 769C rental fee (\$)=	Annual meste placement rate (BCY)=

TABLE 1
Required fleet size for Transportation of waste to sites 1 and 6

WOLLDE VOLUME (NCV)	받복수	HOLL DISTORCE SITE 18	HALL DISTANCE SITE 6	HOLL TINE (NIN) SITE 18	HAUL TIME (MIN) SITE 6	RETURN TINE (NIN) SITE 18	RETURN TIME (MIN) SITE 6	TOTAL TROVEL TINE SITE 10	TOTAL TRANEL TINE SITE 6	PRODUCTION P E BRITE (DCV/HR) IN SITE 1	RODUCTION RTE (BCY/H SITE 6	MEDUINED R) PLEET SIZE SITE 1	REQUIRED PLEET SIZE SITE 6	VER OF SITE 1 OF C
												~		
e s		3 5										~		F. 3
4 6		96.										•	_	2.:1 2.:2
ง้ •		8 6			_							•		X : 1
-	200	8 6			•							~		5 16.38
	200	3	25.840	4.27	A	8.5	4.	34.5	16.18	56. 0.3	57.06	•		15.65
	1 8 2 8											•	_	K j
	8	2.66										•	_	5 <u>5 9</u>
	8	3		5								_		5. F. S.
	163	12,710		2							_	n	_	
	2	17.940	4.240	6.67							_	^		7.14
	160 A	200		2								v		3 17.16
			4 246	A 47								^		17.4I
		2 4										•	_	3 17.6
	8	9										_		2.5
	\$ 4 de	980										~		17. X
	25	2										•	_	
	2 2	3										^	_	0 IF X
	8	3	37,960									2	_	14. E
Ì	30 1													<u> </u>
7	13, 335, 200													

THREE 2 FREUT, WILL COSTS SITES 1 & 6

	187 CD57	MESENT	MESENT	MESON
	SITE 6	FACTOR	SITE 1	SITE 6
1	•	-	0	0
	100,177	0, %15	273,071	657,088
	101, 371	9. W.	282,388	ES 123
	121,371	0.000	28. 46	78,458
	591, 371	9.884	242, 759	761,940
	121,371	0.6219	233,422	722, GA2
	736, 497	6. 7903	224,419	582, 065
	639,659	e. 735	360,006	580,632
	653, 660	0.7307	346, 150	401,359
	99 65	Q. 7026	375, BA6	463,047
	659, 660	6.67%	320,04	45,28
	785,550	0.5%	629,073	519,285
	946, 810	988	470,986	530, 165
	848, 810	9009.0	E Z	509, 774
	1,657,624	0.5775	435, 379	619, 722
	1,127,229	0.3553	418,634	625, 910
	970, 729	0.5339	346, 453	518,280
	471,673	0.5134	471,167	242, 145
	1, 255, 733	0.4936	622,615	787, 983
	•	0.4746	•	•
	17,170,535	•	12,627,719	15, 975, 739

LOSO/UNLORO CIGSTS

Load costs are costs associated with placement of waste in hawl trucks.

Unload costs are costs associated with placement and compaction of the waste at the land disposal facility.

Laad costs are broad on a dezer to unidrow waste autorial and a lauder to place the waste in a hael truck.

Placement costs are based on a dozer and mator grader to move, level and compact the material at the land disposal facility.

Load/unload costs are prosortional to the waste placement rate and therefore are uniform.

Equipment Specifications

114,653	08.08 878 5.	05) 04 051
Spacer (Caterpiller 89, p. 15) GAN(1b)= Flycheel power (hp)= Lhiversal blade	Loader (Caterpillar 9868, p. 288) 6AM(18)= Flywheel power (hp)= Bactet size (cy)=	Motor Brader (Caterpillar 148, p. 79) DAVIDS - Flynbeel pour (hp) - Standard 14' blade

THELE 3 MALLE LOND CHESS --

	ACTIVED TO	FOLKLY PROB. ROTE (BCY)	HOLEY FOIR (6)	100 (8) (8) (9) (9)	VEARS OF CAT 1 CH	20679 (*) (*)	PRESENT MONTH FACTOR	MESSON LONDY
	~	2.	\$	412,006	1-1	7,416,115	12, 166	5,012,470
i	-	\$	n	33,16	<u>=</u>	2,844,909	12.166	1, 936, 360
à	-	4	3	33,76	#-1	1,687,735	12. 166	1,140,762
Total=				466.934		611, 968, 619	•	86,089,592

TABLE 4
MASTE TRANSPORTRITON COSTS
FOR

SITES 1 AND 6

SITE 1 SITE 6 SI

LUNDVINLUM (TRILE 31-+ 23,937,638 16,179,184 23,937,638 16,179,184

427,1199,129 618,606,902 431,106,173 422,174,922

10TA.

1,51,61 2,427,719 7,170,535 5,955,739

HALL COSTS (THRLE 2)

• - A CHARLISH FINCOR HIS BEEN KOKER FOR LEVEL IB KORKER PROCTECTOR

COST ESTIMATE FOR 24-YEAR NULLICUT ON PRINGRY STYE 8-cell concept 250 trajeno cubic yand celes (636° x 636° x 43° HIBM) Estimate is breed on disposal of 16 million cy of matchial

THALE 1 CONSTRUCTION COSTS SITE 1

			3 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	*EOF(5) +	INITION	PRESENT	MESON MESON ADRIN	PRESENT LEPTH CDET. CYSTS
191	QUANTITY/ UNIT	MRICE (6)	1967 (6)		1967 (8)	FACTOR	VE 1-20	MS 0-20
Site Preparation	ă	8 5	969		e Ki	75. 166		N.
Clearing Grabing		•	200		3		4	
Earthmort-cut	3,177,128 BCY	7 1			4			
Earthmork-fill	3,667,440 try	~	11,002,30		25'/2			
Bris	11, 366, 640 bey	m	¥,099,%	<u></u>	1,281,697	25. 1 5.		3 6
Suspent Poildies and Souteney								1
Odermietration Building (60° n 45')	1,800 m. ft	ន	8,00	•	8 9 9		•	000 00
Oneman Part 100 100 100	2	8	180,000	•	90,00		•	
Maintaine Designer (Col. 1959)	7.500	2	130,000	•	150,000	- 900	•	150,000
Sampling laboratory (20° n 20°)	400 sq. ft	S	30,000	•	90,00	1.00	•	8
Hed roads site 1	93,000 ft	ន	4,650,000	6-17	•	12.166	3,556,74	1,555,74
Bitch	140.540 #	•	693,064	•	•	_	673,064	_
Deteration Rend (220's 250's 15')	=	900,04	900 '04	•	990 °¢		-	8
Leachate evaporation pord (200° ± 200° ± 9)	=	110,000	110,000		110,000	8 -	•	8 6 6 7
Monitoring Malls	2 0	2,000	10,000	•	10,000	1.00	•	16,000
Germily Fance	27,120 14	2	542,400	•	542, 480	1.600	•	542, 400
[hi] Combraction (25,000 cv cell)	3	1, 673, 490	1,673,450 107,103,350	6-17	1.673,490	12.166	60,166,237	81,839,727
		. •	9165, 188, 424	1	94,933,065	١		6125, BEB, 738
Engineering design, plans and spec's (106 of total costs)	total costsi		16,918,0h2	a,	16, 916, 842			16, 918, DA
Contingency fund (15% of total costs)			25, 378, 254	_	25, 378, 284			25, 378, 25A
			02 AL 164	ء ا	M7.230, 191			172, 125, PM

e - Canstruction costs occur at years and. es - Initial construction costs are considered to be expenditures occurrad during the first 12 months of operation (years 0 - 1). ess - Besed on a 4% discount rate (interest rate - inflation rate)

THRE 2 Openation and additionance costs site 1

191	90504T 104 008T\$	OPERATION INTERNACE COSTS COSTS	107A. 04H 1967 (\$)	YEARS-4 OF OAM	TOTAL COST	PRESENT ++ MONTH FRCTOR	MESENT MONTH DAM
Waste transportation cost (Table 4)	,			2	77,189,229		18, 806, 922
Pest Suppression	000 '01		40,000	9	720,000	12.63	306, 360
Support Duildings And Equipment Administration Personnel Decen/clean Trailers	900 900 900	8 8 8	4 H	88	36,808 116,808	8 ti	4,45 55,45
Heul/Access Abads	•	20,000	20,000	R	400,080	13.99	271, 800
Surface Mater Centrol System	•	, 000 100	2,000	2	100,000	11.3	67,50
Sampling monitoring wells (quarterly)	3,000	•	\$ 990	R	100,000	11.9	67,350
Main stration Personal	8	1	98 97	8	1.160,080	13.39	747,650
1-510 Manager			900			11.13	391,030
Complete frames	96.5	,	45,000	2		13.134	3.18
	000'09	•	60,000	2	-	13.59	015,400
(Jay 197 auranama)	000'2	•	W. 900	2	576,000	12.659	405, 000
Libralith & Cafeby margares	200.9	•	20,04	2		12.63	405, 088
1-field maintening anderst	90°F	•	25,000	=	630,000	12.639	M3, 065
- Coste bouse technicism	2,000		(Z)	2		12.63	316, 475
	90.00	,	3	Z	=	13.59	
1-servetary	30,00	•	20,000	£	•	5.3	₩.
1016.					636,511,329		62, 231, 308

e - Costs accur at years and to - beard on a 4% discount rate (Interest rate-Inflation)

THERE 3 CLUSHAME COSTS STIE 1

	AT THOMB	TIMO TISCO	TOTAL COST	YEAR-+ OF Expenditure	MORTH NORTH FACTOR	MCSSOT MORTH
Support Buildings And Equipment Decon. Personnel Trailers	8	000 st	15,000	=	4	7,494
Decentaminate Haul Roads Longitudinal roads on site 1 Section roads	643,540 15,000	mm	142, 980 55, 080	22	4	70,545
Surface lister Control Ditch (Secon) Pord (Neson)	140,640	5,000	02, 05 000, 2,	2 2	44	34,710
	•	TOTAL.	1278,240			137,339

e - Costs occur at years and ee - Besed on a 4% discount rate (Interest rate - Inflation rate)

Three 4 post closure costs site 1

5	CHENTIES CONTINUES CONTINU	OPENITION NATIVED WALES	100 100	4.030.10 07.00.10	4 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	PRESIDIT-04 MORTH FACTOR	PRESENT MONTH OF DAR
Support Pulitings And Equipment Againistration Puliting	1,090	8	1,380	8	65,980	7,682	11,63
Serface Mater Control Byston Ditch	•	1,000	1,000	A	30°08	7.652	7,6%
Monitoring Wells	3,000	•	2,000	8	150,000	7.6%	33, 46
Adelnistration Personnel Manager (aart time) Security Board	\$5,000 27,000		\$5,000 \$2,000	88	1,350,000 750,000	7.8%2	197, 380
TOTAL					R, 325, 000		6611,630

0 - Costs occur at years and 0 - Costs occur at years and 00 - based on a 4% discount rate (interest rate - inflation rate)

TABLE S CUST SUPPORT 20 YEAR BUILDOUT SITE I

ST. FRESDIT—+ (8) MORTH	211, 465, 530 172, 125, 644	1,229 25,231,506	278,240 137,339	2, 25, 000 611, 630	6250, 640, 099 8198, 106, 322
CD67. CD515 1987 (4)	Construction (Table 1) 211,48	Operation & Main. (Table 2) 36,511,229	Closure (Table 3) 27	Post Closere (Table 4) 2, 32	TOTAL.* 1250,60
STSDO	Construct	Operat ion	Closure	Post Clo	Ē

e - Sessed on a 45 discount rate (Interest rate - Inflation rate)

29 YEAR BUILDOUR FERTON - D CONCENT RESIGN - DE MILLION CLOIC YAND CELLS

CHRI ESTIMATE FOR 20-YEAR BUILDOUT ON PRINNEY SITE.

D-CELL CONCEPT

CHE MILLION CLOIC WAR (CEL'S { 100x² ± 100x² ± 42° MIB?)

ENTIMATE IN MED. ON THE BISHORM, OF 16 MILLION CY OF WATERIAL.

THELE I CONSTRUCTION COSTS SITE I

	מחשעונוא/ חווו	UNIT PRICE (6)	TOTAL. COST 1967 (6)	YEMIS) → CD61. CD87 CCCA9	1911 194, 44 CDGT, 1987 (8)	MESBIT-444 MOTH FRCTOR	MCSEDIT MCSEDIT MONTH MONTH COMET. COGTS COMET. COGTS WIS 1-20 YRS 0-20	MESENT MORTH CONST. COSTS VAS 0-20
Site Properties	227 acres	9091	- 88 - 88		15. 24.	12.166		405,236
Sections of the section of the secti	_	~	11, 163, 48	417	413,049	19. 1 5.		1 287, 417
Enthumb 4111	675, 600 lery	~	2,026,800		×,980	12.166		1,33,03
	1,950,920 lety	~	11,604,70		i j	12.166	S, 643, 472	* 12 's
Support Balldings and Equipment		i	1	,	1		•	\$
Chainistration Building (40' x 45')	- 100 m	8	8	•	8		•	
Sersonal Been. Insiler (0'x 12'x 40')	3 ~	8 8	6	•	000,000	8	•	
Mintenence Beilding (60' n 1257)	2	& †	98 98 98	•	96,96		•	
Sampling laboratory (20' x 20')	\$ 1	8	8	•	8	8.	•	
theil roots site 1	40,350 ft	8	2,008,000	د .	•	12.166	1,542,041	1,342,941
Burface Mater Control	1	•	•			271 61	67	125
		9		<u> </u>	\$	-		
Lachete evaporation pord (200°s 200°s 5)		116,000	110,000		110,000	1.88	-	110,000
Manitering Wills	2 0	200	16, 000 000,	•	10,000	1.90	•	10, 606
Bearity force	22,200 11	R	#¥,000	•	444,000	98.	_	44,900
Call Construction (1,000,000 cy call)	2	5, 6.36, 399	50, 185, SEA	6.5	5, 636, 399	12, 166	64, 284, 534	64, 923, SU
4.0 TOTA.			9119, 339, 300		67,65K,95K	•		92,36,991
Engineering design, plane and spacis (196 of total conts)	f total costs)		11,933,930		11,933,530			11,500,530
Contingency fund (13% of total costs)			17,900,855	_	17, 900, 855	ı		17,900,855
Total -			114,174,125	ـــا	ומי,ופגינט			112,41,816

 ⁻ Construction costs accur at years and.
 - Initial construction costs are considered to be expenditures occurred during the first 12 months of operation lyners 0 - 11.
 - Instal construction costs are considered to be expenditures occurred during the first 12 months of operation lyners 0 - 11.

29 1538 BUILDLIF FERICO - B CONCEPT RESIGN - ONE MILLION CLORIC WAS CELLS

THELE 2 DICHATION FIRE MINITEMACE CUSTS SITE 1

	OPENTION MINIBORICE CORTS COSTS	ALIMITEMENTS COSTS	1011A. 1987 (6)	45985 + OF OM	A. T. T. B.C.	MESEUT -++ MONTH FACTOR	MENEUTY MONTH UNITED
Mate transportation cost (Table 4)				=	27,189,329		18, 806, 902
bet Depresion	46,000	•	46,000	2	720,000	12.69	306, 368
Apport Delidings And Equipment Administration Personal Beconcilon Incliers	98 4 4	22	8 8 4 5	2.2	39,060	13.99	13,975 74,745
Heal /Access Basis	•	20,000	20,000	2	400,000	13.59	271,800
Berface Mater Centrol Pystes	•		89 si	8	166, 600	13.33	67,58
Sampling andtering wells (querterly)	\$,000	•	₽ 90 1	2	100,000	13.99	67,550
Abeliaistration Personnel	ŧ	•	8	8	1,106,000	5.5	747,450
	\$ \$	•	98		625,000	_	31,63
	8 8	•	4	.	_		
Proceedings recent	9	•	3	&	1,200,000		
	900	•	8	=	_		
1 the 1st a Galletin manner of	200	•	9	=			
City or mineral or annual	14	•	100 M	=			
		•	8	=			
	99	•	99	ĸ.			
1-eartery	98,42	•	20,000	25			
- 9111					(X, 511, 279		62, 231, 300

 ⁻ Casts corer at years and
 - based on a 4% discount rate (Interest rate-inflation)

29 YEAR BUILDOUR PERICO - D CONCEPT RESIGN - DIE MILLION CLOIC YAND CELLS

THELE 3 CLUBACE COSTS SITE 1

•	MUNITITY	1180 1280		MEAN-OF EXPENDITURE	MENDATA MONTH FRETTON	MESENT
Supert Baldings And Equipment Score, forement Trailors	F	\$ 000 fs	15,000	=	9.49	7,494
Decentarisate that Back Longitudinal reads on site I Baction reads	88, 198 13, 600	m m	5, 312 45, 880	==	5 5	41,616 20,212
Burface Mater Centrel Bitch (Beton) Pord (Beson)	3-	- 80 °£	31. € 300 €	22	44	7. v.
	-	TUR.	9183, EM		•	990, GA7

- Darks accur at years and
 - Dasks on a 44 discount rate (Interest rate - Inflation rate)

THILE 4 MOST CLOSUME COSTS SITE 1

	COSTACTOR	CHENTION INTINTEGRAZE COSTS COSTS	TOTAL DEFE	VENES-	1 5 E		
Suport Buildings And Equipment Aministration Building	1,000	906	1,30	8	45,000	7.0%	5 , ::
Defect lister Central System Ditch	•	1,000	1,000	8	86 A	7.	7,8%
Monitoring Mells	3,000		S, 000	R	136, 800	7.0%	33,45
Abinistration Personal Hanger (per tim) Security Buard	સ્ શ્		શે. શુ 8 8	88	1, 330, 000 730, 000		JEE, 140 197, 306
TOTAL - Coult over the State and				•	60, 25, 59		8511,63

- Casts occur at years and
 - Lased on a 4% discount rate (Interest rate - Inflation rate)

THELE S CHEM BALLHOUT SO YEAR BALLHOUT BITE I

	14,174,125 128,421,816	3 E, 23, 38	/5 g	611,630	118, 19, 050 6148, XX5, 601
CDET. CDETS 1907 (8)		Species I tain Itale 21 34,511,229 ES,231,536	15 to	le 4) 2, MS, 000	918,194,0
	Construction (Table 1)	Operation & Main.	Clears (Table 3)	Part Cleases (Table 4)	TOTAL.

e - Bessé en a 45 discourt rote (Interest rote - Inflation rote)

COST ESTIMATE FOR 20-YEAR BUILDOUT ON PRIMANY STRE D-ECL. CONCEPT 1.5 MILLION CLOSE WAND CELLS (1004" x 1004" x 68" MEN 3 ESTIMATE IS DIRES ON THE DISPUSAL OF 16 MILLION CY BE WATERIAL

THALE 1 CONSTRUCTION COSTS SITE 1

		1110	101AL	YEAR (S) → CONST.	INITIAL -44 CDIST.	MEXBUT-+++ MONTH FORTING	PRESENT PRESENT UDRIN UDRIN CONST. CUSTS CONST. CUSTS	MESENT MORTH COSTS VIE 6-20
		181 25184	in in	committee in the commit	i i i	5	2	
Site Preparation	•	8	£		5	75.51	276. 787	290, 773
Clearing Problem		₫ '					45 64 41	22.2
Earthmort-cut	4, 984, 400 tery	~	14, 713, 200				10, // J. 510	11, 317, 333
Earthand-fill	154,200 tr.y	~	462,600		17,116	_		
-	5, 760, 000 tery	~	17,280,000	6-17	63,36	12.166	12,653, 127	13,252,487
Second Buildings and forigated								
Odministration Beildine (40' m 45')	1,800 M. ft	8	90,00	•	90,00		•	8
	2 ~	90.00	180,000	•	180,000		•	000 '0 9 1
Maintenance Brithing (60° n 123')	7,500	£	150,000	•	150,000		•	150,000
	400 sq. ft	83	90,00	•	90,000	1.00	•	96 96
Heel roads site 1	31,360 11	8	1,578,000	4-17	•	12. 166	1, 199, 872	1, 199, 672
Surface later Central	Ş	•	36 26	Ş	•	12.16	211.501	233.501
		•			\$			
Destantion Ford (250'n 220'n 15')	2 :	000,00		>			•	110.000
Leachste evaporation fond (200's 200's 3")	2	114,000	96,01					
Monstoring Mells	2 0	2,000	10,000	•	10,000	1.000	•	10,000
Security Fence	19,680 1f	æ	393, 640	•	393,600	1.80	•	393, 600
Call Construction (1,500,000 cy cell)	10.667 ••	5,571,588	59, 4.R. 129	6-17	5, 571, 588	12.166	40, 954, 209	16, SES, 791
9.0 TOTAL *			895, 214,615		67,850,039			674,279,679
Engineering design, plans and starts (10% of total costs)	total costs)		9,521,462		3¥'185'6			3, SPI, 462
Contingency fund (15% of total costs)			14,282,192		14,282,192			14,282,1%
• (e-15)			6119,018,269		431,653,692	•		AS '890'860

Construction costs accur at years end.
 Initial construction costs are considered to be expenditures occurred during the first 12 months of operation (years 0 - 1).
 Based on a 45 discount rate (interest rate - inflation rate)

THREE 2 Dienation and withoute (3515) Site 1

1 01	GREATTION INTERNACE COSTS COSTS	IN INTERNACE COSTS	101A. 1987 (\$)	YEARS -	TOTAL COST	PNESENT -+* MORTH FACTOR	MESON MORTN Our
Wate transpertation cost (Table 4)	•			2	27,1891,729		16, 806, 902
Dest Suppression	000 '00	•	40,000	2	720,000	12.63	306, 360
Support Buildings And Equipment Reministration Personal Occur/clean Trillers	900 g	3 3	4, R.	22	36,000 110,000	13.39	33,975 74,745
Havi /Access floods	•	20,000	20,000	æ	400,000	13.59	271,800
Surface lister Centrol System	•	, 000 1	\$,000	R	100,000	11.99	67,950
Sampling monitoring wells (quarterly)	3,000	•	960 1	R	100,000	13.59	67,950
Mainistration Personnel		•	18	æ	1, 100,000	13.99	
Later transfer format	\$2,00	•	45,000	5	655,000	13.134	391,030
Lead the former	5,000	•	45,000	61	855,000	12.134	
24 showing	60,000	•	000'03	2	1,200,000	17.39	
1-Ob/Or manage	88		800'2	=	576,000	12.659	
1-than 10 A Caffed agreement	200.00	•	86.88	2	576,000	12.639	
Affect of the second of the second	12	•	22,000	2	630, 800	12.639	443,065
- Control and the control of the con	8	•	8	9		12.639	
D.Committee	000'09	•	9	2	-	13.59	
Automotive I	20,000		000'02	æ		13.59	
					636,511,329		625, 231, 508

+ - Cost occur at years and s+ - Based on a 4% discount rate (Interest rate-Inflation)

THOLE 3 CLOSLONE COSTS SITE 1

					PRESENT -+		
118	CLIO(T)	E TSES	10 TO 10 TO	EXPENDITURE	FACTOR	MESENT	
Support Buildings And Squipment Discon. Personnel Trailors	3	090 °E	15,000	=	\$	7,464	
Moontaninste Neal Anada Longitudinal roads on site 1 Section roads	16, 800	m m	95 95 95 95 95	22	9.5	24, 877	
Serface Water Control Distr. (Decen) Pord (Masore)	6. 36 1	2,000	24, 160 5, 000	22	2.0 24.0	11, 938 844, 5	
	_	TOTAL •	139,580	ì	•	168, 89 7	

Casts occur at years and
 - Dased on a 46 discount rate (Interest rate - Inflation rate)

THBLE 4 FOST CLOSURE COSTS SITE 1

ITE	OFERRITOR COSTS	OCEANION MAINTENAGE COSTS COSTS	\$ 5 1 1 1	YESTES -	1 20 20 20 20 20 20 20 20 20 20 20 20 20	MESENT-00 MORTH FACTOR	MESSON MORTH OF
Support buildings And Equipment Aministration Building	1,000	8	96,1	R	45,000	7.892	11,63
Surface Water Centrol Byston Ditch	•	1,000	1,980	8	30,00	7.652	7,892
Monitoring Mells	2,000	•	5,000	Я	150,000	38.	39, 66
Abunistration Personnol Nanger (part time) Security Geard	45, 900 25, 900	; ;	\$\$. \$90 \$90	88	30 1, 350, 000 30 750, 000	7.6% 20.7	197, 300
101A.					R, 325,000	•	9611,630

e - Costs occur at years and se - besed on a 4% discount rate (interest rate - inflation rate)

THOLE 3
COST QUESTIV
20 FERR BUILDOUT
SITE 1

PRESBAT-4	AS, 500, 522	25,231,506	350 6.8, 857	000 611,630	1157, 994, 178 6123, 995, SS7
CDIST. CDSTS 1987 (8)	ble 11 119,018,269	Operation 6 Main, (Table 2) 35,511, 229	139,560	ble 4) 2, 25, 000	1157,994,
20078	Construction (Table 1)	Operation 6 Min	Closure (Table 3)	Post Clesere (Table 4)	10TA.

e - Jeans on a 45 siscount rate (interest rate - Inflation rate)

29 VERN WILLIAM FERIED - 9 CINCEPT RESIDU - TMEE MILLION CLOIC VIND CELLS

COST ESTIMATE FOR EN-YEAR EALLIANT ON PROPERT STR.
P-COL CONCEPT
THERE MILLION COREC WAS COLLS (1629" = 1629" = 42" MISH)
ESTIMATE IS SANDED ON THE SISPOSAL OF 16 MILLION CY OF WITERIAL

MALE 1 CONTRACTION CUSTS SITE 1

			Ā	+ (S) MGA	INITIA -++ MENDIT-+++	MESEBIT-466		
2	THE LAST		1387 (8)	CONST. COST COOMS	1987 (8)	FACTOR	VIE 1-20	ME 9-20
lite Preparation		į	**	-	9	35.55	W. 134	3
Clearing Grabbing		} "			5			₹
Cortingent cut		•			3		2,063,068	
Estimat-fill Pro	1, 204, 300 try	. ~	11,113,360	ī	411,26	7		6,349,407
Expert Delibitings and Equipment		1		•	1			3
Mainistration Building (40 n 49)	2	8 (5 6			•	
	* .			•	15	8	•	3
Mintmens Bilding MV = 127 Septing tehendery (SY = 287)	e i R	g 8		•	8		•	30 '8
theil reads sife 1	27,000 ft	8	1, 332, 000	6-17	•	12.166	1,68,48	1,658,446
Berfass later Carbrel					•			-
	£ 28.3	•	25.25 25.45	<u>;</u>	\$			
Detection band (250°s 250°s 15°) Leachate evaporation pend (200°s 200°s 5°)	: :		110, 800		110,000		•	116,000
Manitoring Wells	8 0		<u>6</u>	•	36, 80	8.7	•	3
	21.36 15	2	427,800	•	47,800	1.00	•	K7,330
		1			47 47	51 61	\$0. W. D.	67. 65. 67
Call Construction (2,000,000 cy cell)	3		1601, 61		in the second			- 1
## TIM.		. •	9114, 778, 753	۱ ـــ	117,061,971			9. IS. 93
Engineering design, plans and upac's 1166 of botal crotel	' total conts)		11,477,873	_	11,477,679	_		11,477,679
Contingency food (15% of total conts)			17,216,819		17,216,819	_		17,216,819
1			014,473,491	ــ ا	16, 25, 659	٠ _		6120, 249, 797

 ⁻ Construction costs eccur of yours and.
 - Initial construction costs are considered to be expenditures occurred during the first 12 earlies of eparation fyeurs 0 - 11.
 - Beand on a 4% discount rube (Informat rube - inflation rube)

THELE 3 CLOBANE COSTS SITE 1

	SERTITY.	TIME	TOTAL	YEAR-+ OF EXPENDITURE	MERBIT -++ MORTH FRETTOR	FEBOR FEBOR
Supert Dildings And Swigared Secon. Personnel Trailors	•	\$,000	15,000	=	6.49	7,404
Meantanisate that heats Langitudinal reads on site 1 Section reads	41 88 88		41,760	22	44	13°8
Murface Mater Control Mitch (Mason) Four (Masons)	41,760	- 98	08 °5	22	**	10, 38, 2, 48,
	F	TOTAL.	9157,640		ı	663,003

Costs accur at years and
 - Desail on a 46 discount rate (interest rate - inflation rate)

THRLE 4 MUST CLOSUME COSTS SITE 1

2	OPERATION CORTS	CHENTION MAINTENNEX CLOSTS CLOSTS		75385 + 07 088	Ĕ ā	MENDA 44 MOTH FACTOR	
Support Deliblings And Equipment Assistantion Delibling	1,000	ş	8,1	8	\$5,000	7.62	11,62
Derface Mater Central System Ditch	•	1,00	1,000	8	96 '95	7.62	3.8°
Henitering Hells	980 °S	•	4 8	8	130, 800	7.58	33, 55
Maintefration Personnal Navager (part tion) Becarity Baard	축 편 용 용		ą ų 8 8	88	1, 258, 000 25, 057	7.50	256, 100 197, 200
					8, EE, 88		831,138

TOTALs accur at years and co - Bessé an a 45 discount rate (Internet rate - Inflation rate)

TABLE S COST SIDERRY 29 YEAR BULLION SITE 1

MENENT.	120, 249, 797	23,231,300	£1,000	611,630	14, 15, 23
CD67. CD678 1307 (8)	144,474,491 120,249,797		127,640	2, 325,000	11E, 437, 460 0146, 135, 939
2,50	Construction (Table 1)	Operation 6 Main. (Table 2) 36,511,329	Clears (Table 3)	Dat Clause (Table 4)	WIR.

^{4 -} Bead on a 4% discount rate (interest rate - inflation rate)

Acety Hountain Arsena! Task 27

Ebaseo Services Inc. Estimate of Maste Transportation Costs for a 30 Year Buildout Period

Hotes

Meste transportation costs are estimated in two parts: Meal costs (Table 2) and Loading/unloading costs (Table 3). Meste Transportation Costs to sites 1 and 6 (Gemestion of tables 2 and 3) are presented in Table 4.

The first and last years of the buildest period are used for facility construction and closure,respectively. Ladding/unloading costs are unifore throughout the buildost seriod. Equipment production rates are based on 50 minute hours (63% efficiency).

Equipment costs are based on an hourly rental fee that includes overhead for a driver, a michanic, fuel, maintenance and seare parts. Mental costs include a discount for both a volume fleet and long term rental agreement.

Equipment rental costs were provided by EMSCO Constructors Inc. Esuppent production rates were estimated from the IZMs, of the Caterpillar Performers Handbook.

HOLL COSTS

Haul costs are considered to be costs associated with the transportation of waste from the centamination site to the land dissocial facility. Table I provides an estimate of the figet size and time required to transport waste from sections. to disposal sites 1 & & Hawl distances were measured from the center of "sections" to the centroid of the disposal site via the existing road grids. Waste volumes in sections were taken from the DAUS or the Phase I Contamination Accessance Reports if evailable. The annual "haul costs" for transportation of maste anterial is presented in table 2. A summary of heel costs by sections are presented in table 1 for both sites 1 and 6.. Heel costs depend on heel distances and thus vary over the builtook period. Maste material is transported in end dump haw! truchs (off-road size). Man! costs are calculated individually for sections.

Equipment Specifications

End damp ham) truck (Caterpillar 7695, p. 226)

= 70,0001b or 35 tons * 22.8 cy (struck) Gross vehicle seright (944)=138,0001b Empty vehicle meight (ENA)= 68,00016 Capacity

Estimation of haul truck production rates

New! truch production rates are a function of the travel time to and from the centamination site and land dissonal facility. The total reund trip travel time is the som of the heal time, return time and load/unlood time. The haul times and retern times can be estimated by equations 1 and 2 derived from the Cateraillar Handbach (a. 233-234) The load/enload time is an assumed constant.

- were I is in feet, beamed on the GMM and a total resistance of 45 (2% rolling + 2% grade) Eq. (1) Hawl time (min) = 0.22 + 4.81E-4(X)
- Eq. (2) Return time (min)= 0.24 + 2.50E-4(1) mare I is in feet, based on the EM and Of total resistance (25 rolling and -24 grade)

Inout parameters for calculation of Table 1 and 2.

8	260 (5 days/week-52 weeks/year)		2. 15	£. 33	476,237
Noste placement years.	Construction days per years	Begin maste placement at and of year	Load/unload tree (minutes)=	Hourly 7650 rental fee (6)*	Amusl waste placement rate (BCY)=

Maguired fleet size for Transportation of waste to sites I and 6

SECTION An	WOLLNE (DCY)	HALL DISTANCE SITE 18	HOLL DISTONCE SITE 6	HOLE (MIN) SITE 18	HERA THE CHIND 1 SITE 6	METURN TINE (NIN) SITE 18	TINE (NIN) SITE 6	TOTAL TROVEL TIME SITE 18	TOTAL TRAVEL TIVE STEE 6	PRODUCTION PRITE (BCV/HR) S17E 1	PREDUCTION ORTE (BCY/ME) SITE 6	REBUINED PLEET SIZE SITE 1	REDUINED PLEET SIZE SITE 6	NEW OF CLEAN UP SITE 1 BR 6
1	3,996,000	3.100	16.80	1.3	9. 30	8.	3.4	5.15				_		-
	1 630, 700). 	07571	7.7		8	3.13	25.4		_		~		230
	2,165,800	13, 700	15,840	4		197	2.3	13.66				~	_	17.014
	1,715,600	13,700	82,120	4		3.67	5.11	13.66					_	3.15
	47,300	2.5	11.520	ี ส <u>.</u>		0.7	3.12	¥.4		_		-	_	25.25
	122,000	4	16,040	4.21	24		4.45	9. 3.	16.18	36.03	57.06	~		1 K 35
	8	6.43		4.27				3,6				~	•	32.22
	1,000	12,660		6. 3		34		12.63				~	_	25.75
_	1,000	17.940		7				17.07				•	_	2 2 2
	163,500	12,710		E.3				12.67			_	•	_	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
_	¥.200	17.990		6.07				17.11			_	•	_	2 3K. 111
	169,000	12,500		3				12.70				-	-	# # W
24	140.000	17.980		P. 87				17.10			_	•	_	2 K.S.
	147,000	24, 250	11.280	11.69				₹.18				•		1 X 13
	97,000	18,940	11,880	S. P.				17.67				•	_	3 27.140
	24, 80	16,990	28.080	10,				17.91	_			•	_	5 27.34
	23	16,300	27,360	4.08				15. J	•••			•	_	5 27.65
	47,800	16, 990	27,400	12,				17.91	_			•	_	5 27.967
	444,000	35,55	37,960	14.43				M.	•			^	_	
1														Z.
	13, 335, 200													

THRIE 2 FOUNT HAIL COSTS SITES 1 & 6

PRESENT PRESENT	FACTOR SITE 1	-	0.9615 175,545	C. 20 166, 7%	0.6690 162,302	0. 6546 156, 059	0.6219 150,057	0. 7903 144, 285	0.7599 138,736	0.7307 133,460	6, 7036 178, 26.3	0.6756 805, 743	0.64% 157,629					0,5339 162,601					_	_	_				_	0, 3335 303, 619	0, 3207 0	
1861	SIR 6	•	573,024	573,024	573,024	573,024	573,024	573,024	573,024	573,024	45,90		423,682	423,642	423,682	453,682	483,682	43,642	545, 664	545,664	345, 66A	545,664	620,240	724,647	724,647	724,647	510, 736	273, 389	648, 361	1, 151,015	•	
1861	SITE 1	•	182, 367	182,567	182,567	182,367	182,567	182,387	182,367	182,567	22,123	304,349	304,549	304,549	304,549	304,549	304,549	304,349	484,673	464,673	464, 673	464, 673	484,673	46A, 673	484,673	464,673	374,827	571,532	641,212	911,064	•	
	YEAR	-	~	~	•	67	٠	~	•	•	2	=	~	=	=	2	3	=	2	2	R	2	ន	ສ	₹	ĸ	æ	2	Æ	ೱ	8	ł

LISTO /UNLIDED CUSTS

Unload costs are costs associated with placement and compaction of the waste at the land dissocial facility.

Load costs are based on a dear to windrow waste unterial and a leader to place the waste in a heal truck.

Placement costs are based on a dozer and unfor grader to more, level and compact the naterial at the land disposal facility.

Load/unload costs are promortional to the waste placement rute and therefore are uniform.

A summary of annual load/unload costs are presented in table 3. Load costs are costs associated with placement of maste in haul trucks.

Equipment Specifications

08. 300	58,000 270 5	82 83 83
Dozer (Cateryillar D78, p. 15) GW(1b)* Flywbeel power (hp)* Universal blade	Loader (Esterpillar 990C, p.287) GW(1b)= Flycheel power (hp)= Buchet size (cy)=	Notor Brader (Caterpillar 128, p. 75) GW(161= Flywheel power (hg)= Standard 10* blade

TRELE 3
AMERIC LONDAINCOND CORTS --

	덮	HOUNEY PROD. MOTE	HOLE	CHECK-++	YEARS	CIETS	PRESENT	MESENT
EBUTMENT	EWITED	وَ	REDITAL (8)	ENTA. (6)	- 1	1967 (6)	FACTOR	
	•	S	3	24.80 80.41	1-38	7,134,440	16.663	4,245,722
£.	~	8	\$	225,306	8 -1	6,306,357	16.663	3, 754, 267
	-	4	8	78.	8 -1	1,648,192	16.663	38 0, 65 1
Total:				65.38,970		615,091,149	ı	058,086,89

^{• -} Load/unload costs are the same for sites 1 and 6 • • - Bused on 8 hour days 260 days per year

260 days per year

TABLE 2 FROUNT, HOLL COSTS SITES 1 & 6

COST SITE 1	00ST S1 TE 6	MONTH FACTOR	MORTH SITE 1	SITE 6
•	•	-	•	•
283,993	691, 371	0.9615	273,071	657,048
8	101, 371	9.84	262, 558	ଅ \ ଅ
86	691,371	0.8830	22,469	25,456
8	691, 371	0.654	242, 759	761,948
좛	171,371	0.8219	233,422	72,62
<u>\$</u>	736, 497	0. 7903	324,419	582, 065
₹	659,060	0.7599	360,006	280'83S
Į	659, 060	0.7307	346, 160	48,369
ž		0.7026	38,94	463,047
Ž	659, 060	0.6736	320,044	445, 238
2		0,6436	429,073	510,285
2	648, 810	0.6246	470,986	530, 165
8	848, 810	9009 0	を対	509, 774
8	1,057,024	0.5775	435, 379	619, 722
g		0.3553	418,634	62,90
8	970, 729	0.5339	346, 453	514,280
787	471,675	0.5134	471,167	242, 145
2	1, 355, 783	0.4936	622, 615	767, 983
•	•	0.4746	0	•
13.691	67, 170, 535	•	812 753 54	07. 700 A

LOGO/UNLORD COSTS

Load costs are costs associated with placement of waste in hawl trucks.

Unload costs are costs associated with placement and compaction of the waste at the land disposal facility.

Load costs are based on a dozer to windrow waste material and a loader to place the waste in a haul truck.

Placement costs are based on a dozer and motor grader to move, level and compact the material at the land disposal facility.

Load/unload costs are proscritional to the waste placement rate and therefore are uniform.

A summary of annual load/unload costs are presented in table 3.

Equipment Specifications

114,653	85,560 375 7	40,630 150
Dozer (Caterpillar 89, p. 15) 6W(1b)= Flycheel power (hp)= Universal blade	Loader (Caterpillar 9086, p.286) 6AN(1b)= Flywheel power (hp)= Bucker size (ry)=	Motor Grader (Caterpillar 146, p.79) BAN(1b)= Flysheel power (hp)= Standard 14* blade

TABLE 3 RELIE LONDAINCHO COSTS -

		HOUTE			YEARS		PIESDIT	
EQUIPMENT	MEDINED	PACIO. NOTE (SICY)	FOTA (8)		OPENATION	1967 (6)	FACTOR	E SELECTION OF THE SELE
Dozer	~	1,182	\$	412,006	e	7,416,115	12. 166	12, 166 5, 012, 470
Loader	-	8	t	39,162	9-	2,864,909	12.166	1, 936, 360
P M	_	4	\$	33,766	1-18	1,647,755	12.166	1, 140, 762
Total=				456,934		911,988,819	•	96,089,592

Load/unload costs are the same for sites 1 and 6

^{. . .} Bangd on 8 hour days 250 days per year

TABLE 4
LASTE TRANSPORTRITON COSTS
FOR

SITES 1 AND 6

EXPENDITURE 1987 (4) MORTH 1967 (5) MORTH 1967 (6)
TUTA.= 627,189,329 618,606,902 431,106,173 422,114,922

23, 937, 638 16, 179, 184 23, 937, 638 16, 179, 184

LOSO/UNLOSO (TRBLE 3)-4

+ - A COMPENSATION FACTOR HAS BEEN MORED FOR LEVEL B NORICE! PROCTECTON

COST ESTIMATE FOR 24-YEAR WILDOUT ON PRIMARY SITE
8-CELL CONCEPT
250 PROJECULO DIBIE YARD CELLS I 636" = 636" a 43" HIBH)
ESTIMATE IS BREED ON DISPOSAL OF 16 MILLION CY OF MATERIAL

THALE 1 CHATTALCT TON COSTS SITE 1

1184	GLONGITY/ UNIT	UNIT PRICE (6)	1019L CDST 1967 (6)	YEAR(S) -+ CDNGT. CDST CCCURS	INITIAL-++ CD6T, 1967 (\$)	PRESENT -*** NORTH FRETOR	PRESENT PRESENT ADRIN MORTH CONST. COSTS CONST. COSTS VISS 1-20 VISS 0-20	PRESENT LIDRIN CDIET. CDSTS YRS 0-20
Site Preparation	70	0003	969	₽	κ ί	12. 166	209,640	55. AS.
Clearing articolny	12 Si Ci C	~	0 23 6		25.666		6.979,234	7, 331, 914
	2.67.40 Prv	. ~	11.002.320		407,086		6,056,351	6, 463, 437
tertmork*1111 Berus	11, 36, 640 bry	M	34,099,920		1,261,697		24, 969, 36A	26,231,061
Support Buildings and Equipment		S	8	•	8	9	•	8.00
	1 - M - C - C - C - C - C - C - C - C - C	8 8			180,000		•	180,000
		3 6			000 051		•	150,000
Maintenance Building (60° x 123°) Sampling laboratory (20° x 20°)	400 sq. ft	e g	90,00		90,000		•	8,000
Haul roads site 1	93,080 ft	ន	4,650,000	6-17	•	12. 166	3,525,74	3,525,74
Surface Mater Centrel	,	•	1			27. 67	£30 A£4	£78 P£4
Ditch	2 049,041	9		<u> </u>	9	-		
Detention Port (20" x 20" x 13") Leachate evaporation pond (200" x 200" x 3")	: :	110,080	16,000		110,000		•	110,000
Monitoring Mells	8 %	2,000	30,000	•	10,000	1.00	•	10,000
Security Fence	27,120 19	8	542,480	•	542, 400	7.00	•	542, 400 0
Cell Construction (250,000 cy cell)	2 3	1, 673, 490	107, 103, 360	6-17	1,673,490	12.166	80, 166, 237	61,639,727
SIB TOTAL*			169, 188, 424		M, 933, 085			1129, 828, 738
Engineering design, plans and spec's (10% of total costs)	total costs)		16,918,662		16, 918, 842			16,916,042
Contingency fund (13% of total costs)			25, 378, 254		25, 378, 264	. (25, 378, 254
- (14)		_	6211, 485, 530	١ ــ	847,230,191			117, 125, 8M

 ⁻ Construction costs accur at years and.
 - Initial construction costs are censidered to be expenditures accurred during the first 12 months of contration (years 0 - 1).
 - Besed on a 4% discount rate (interest rate - inflation rate)

THREE 2 Openation and maternance costs site 1

5 11	OPERATION COSTS	OPERATION INTENNACE COSTS COSTS	1010. 064 1967 (8)	YEARS-+ Of Oan	TOTAL COST	PRESENT -++ MORTH FRECTOR	MESSAT
bete transportation cost (Table 4)	-			2	27,189,229		18, 806, 902
Dust Suppression	900,04	•	900'04	er er	720,000	12.65	36, 36
Suport Buildings And Equipment Administration Personel Deconclean Trailers	2, 000 2, 000	20 20	4, R. 80, R.	22	50,000 110,000	13.39	33,975 24,45
Hew! /Access floads	•	20,000	8,88	R	400,000	13.59	271,800
Surface Water Control System	•	3,000	\$,000	2	100,000	11.8	67,560
Sampling monitoring wells (quarterly)	S, 000	•	\$ 000	8	100,000	13.59	67,350
Administration Personnel	8	•	Ę	8	1, 100,000	85°E	747.450
1-Construction former	98	•	5.00	2	900,000	13.134	391,030
1-Expliting forman	45,000	,	45,000	19		13, 134	391,630
2-Laborates	60,00		000'09	&	-	13.59	815, 400
1-00/00 nersome)	200	ı	200°24	2		12.659	405, 988
I-Health & Safety Dersonnel	8	•	25,000	2		12.659	405, C 88
1-field maintening second	98 14	•	20,000	9	630,000	12.659	443,065
1-Scale house technician	8		98,132	2	450,000	12.639	316,475
2-Serurata	90.09	•	900,000	8		13.59	115,400
1-sacretary	90,00	•	900'02	R		13.39	271,800
* 3)E					136, 511, 329		62, 231, 508

•

+ - Costs occur at years and ++ - Based on a 4% discount rate (Interest rate-Inflation)

THBLE 3 CLOSURE COSTS SITE 1

				188	ST-JNGS-BE	
1191	ALIBELLE TY	TIMO TSOO	TOTAL COST	OF EXPENDITURE	MORTH FACTOR	PRESENT MORTH
Support Buildings And Equipment Decon. Personnel Trailers		000 °s	15,000	91	9.4	7,404
Decentarinste Mast Roads Longitudinal roads on site 1 Saction roads	47,640	mm	3. 3. 88	22	9. 9. 9.	70, 545 22, 212
Surface Water Control Ditch (Bucon) Pord (Rusove)	140,640	5,000	5 8 8 8	22	\$ * * * * * * * * * * * * * * * * * * *	34,710
	-	TOTAL.	4278,240	١.	•	\$137,339

- Costs occur at years end
 - Based on a 45 discount rate (Interest rate - Inflation rate)

TABLE 4 Post Closure costs site 1

191	CDETAIL	OPENATION MAINTENANCE COSTS COSTS	T0TA. 044	VERIES-4 OF DAM	TOTAL DOM	PAESBAT - 40 MORTH FACTOR	PRESENT MORTH OF CASH
Support Puldings And Equipment Administration Duilding	1,000	995	1,500	я	45,000	7.892	11,628
Surface Mater Control Byston Ditch	•	1,000	1,000	8	30,00	7.882	7,8%
Monitoring Mells	2,000	,	2,000	Я	150,000	7.6%	3
Administration Personnel Manager (part time) Security Guard	25. 1 <u>0</u> 88.	, ,	\$\$.00 000,000	88	1, 350, 000 750, 000	7.8%. 7.8%	
101A.*				•	R, 325,000		9611,630

Losts occur at years and
 - Based on a 4% discount rate (Interest rate - Inflation rate)

TABLE 5 COST SUBBRAY 20 YEAR BUILDOUT SITE 1 CONST.

COSTS PREBRIT
COSTS PREBRIT
CONSTruction (Table 1) 211,445,530 172,125,644

Construction & Nain. (Table 2) 36,511,229 25,231,508

Closure (Table 3) 278,240 137,339

Post Closure (Table 4) 2,255,000 611,630

TOTAL 6250,600,099 9199,106,322

a - Based on a 45 discount rate (Interest rate - Inflation rate)

29 YEAR BUILDOUT PERIOD - D CONCEPT RESIGN - ONE MILLION CABIC YAND CELLS

COST ESTIMATE FOR 20-YEAR BUILDOUT ON PRIMARY SITE
D-COL CONCEPT
ONE HILLIAN CLOIC WAS CRUE (100" x 160" x 43" MIGH)
ESTIMATE IS DISED ON THE DISPOSAL OF 16 MILLION CY OF WATERIAL

TABLE 1 CONSTRUCTION COSTS STTE 1

	QUANTITY/ UNIT	UNIT MICE (4)	TOTAL COST 1987 (6)	YEAR(S) -+ Coust Occurs	INITIAL-44 PRESENT-444 CONST. MORTH 1987 (4) FACTOR	MESENT-+++ MORTH FACTOR	MORTH MORTH CONGT. CUBTS VRS 1-20	MORTH MORTH CONGIT. COSTS YRS 0-20
lite Preparation	5	90	98, 80		19,492	12.166		
		*	11.163.49		413,049	•		
E-theory (1)	675.680 EV	· **3	28 28	11	74,992		1,44,106	
Person	3, 522, 520 key	. ~	11,658,760	6-17	11 11			
Second Bildings and Engineers								
Attention beildine (40' a 45')	1, 900 m. ft	8	98,98	•	8,08		•	96.98
Personnel Bacan. Trailor (6'n 12'n 40')		90° 96	180,000	0	180,000		•	180,000
Mintmance Delidine (50 m 125)	7,500 88	8	150,000	•	150,000	98.	•	26,93
Sampling laboratory (20' n 20')	400 mg. ft	8	900 '00	•	90,00	99.	_	8 8
theil roads site 1	40,350 ft	8	2,028,000	¢17	•	12.166	1,58,041	1,342,041
Surface Water Control Bitch Betantion Pend (220'n 250'n 15') Laschafe evaporation pend (200'n 200'n 5')	# 1 1 3	40,000	A 4 91 000 01	600	0 40,600 110,000	12.166 1.000 1.000	331, ta	331, 450 46, 600 116, 900
Manitoring Malls	2	2,000	10,000	•	19,000	1.000	•	10,000
Sewity Force	22,200 14	8	444,000	•	## '89	1.00	•	86°¥
Cell Construction (1,000,000 cy cell)	2	5,636,339	90, 185, 38A	<u>-</u>	5,636,339	12.166	64, 284, 934	69, 925, 533
See Total.		. •	9119, 239, 300	1 _	67,696,906			92, 386, 931
Engineering design, plans and spac's 1106 of total costal	total conts)		11,933,930		11,933,530			11, 923, 539
Contingency fund (15% of total costs)			17,900,855	_	17,900,855			17, 900, 655
7			1149, 174, 125		107,531,731			918' KI' 016

- Construction costs acres at years and.
 - Initial construction costs are considered to be expenditures occurred during the first IR anniha of operation lynars 0 - 11.
 - Exemple on a 4% discount rate (Interest rate - inflation rate)

TABLE 2 CHEURTION FIND HOLINTEGRACE COSTS SITE 1

	DESIRTION INTERFECE COSTS COSTS	RENTENDACE COSTS	101AL 06H 1987 (6)	YESHS +	707AL COST	PRESENT	MENENT MOTHY COM MOTHY
Mate transportation cost (Table 4)				=	18 27,169,329		16,866,902
bet Supression	40,000	•	40,000	=	720,000	12, 63	506, 360
Supert Delidings And Equipment Administration Percent Desertion Trailers	000 % 000 %	88	95 s	& &	30,000 110,400	13.9	33,57 34,47
ibul Access fluids	•	20,000	20,000	&	400,000	13.9	271,800
Burface Mater Control System	•	S, 000	3,000	8	100,000	13.35	83,73
Sampling sonitoring wells (quarterly)	3,000		\$,000	æ	100,000	E 23	67,350
Mainistration ferconal	1	ı	8	8		5	747
1-51 to Manager	8 8 8 8	, ,	1 4 2 8		•	12.13	3,15
Levillities forms	9	•	\$. 600	•	650° CS	12.134	98,E
2-Calendar	98	٠	3	2	-	13.59	815, 408
1-CB/IE corscore!	9	•	90 'A	2		5.5	405,08
1-thailth & Before gargorer!	8 N	•	8	91	576,000	12.63	405, 088
1-field engineering support	98 '88 18 '88	•	00 K	=		12.63	443,065
1-State house technicism	8	•	8	2		12,63	
Aprelity	3	•	99	2	<u>-</u>	11.3	
1-escretary	20, 600	•	20,000	æ	400,000	13.39	
					136,511,329		12, 231, 336

e - Costs occur at years and ee - Beaud on a 4% discount rate (interest rate-inflation)

THALE 3 Closure costs Site 1

1784	GLOSTITY	COURT	TOTAL COST	YEAR+ OF EXPENDITURE	MESBOT ++ LORN FRCTOR	MESSON
Support Daildings And Equipment Decen, Personnel Trailors	æ	5, 000	15,000	3	0.494	7,404
Decentarionto Heal Books Longitudinal reads on site 1 Section reads	40 40 40 40 40 40 40 40 40 40 40 40 40 4	m m	64,312 45,000	22	9.49	41,616
Surface latter Control Bitch (Brow) Ford (Brows)	19	1,000	34, XE	22	9 9	35 % 38 %
	=	TOTAL.	183, GA	1 _		690,647

Costs occur at years and
 - Besul on a 45 discount rate (interest rate - inflation rate)

TABLE 4 Post closure costs 817E 1

					!	PRESENT -++	PREBENT
	CONTENSION ICON	COURTS CARTS CARTS		4 00 T		FACTOR	
Suport Dildings And Equipment Administration Duilding	1,000	98	98.1	Я	65,000	7.6%	11,638
Serface lister Centrol System Hitch	•	1,000	1,900	A	30,000	7.6%	7,692
Manitoring Mells	900 ¥	•	5,000 1,000	8	150,000	7.6%	33,66
fibrinistration Personal Manger (per time) Security Baard	4, 1 <u>1</u> 8 8		ર્જ શ્રું 8 ક	88	1,350,000	7.82	355, 140 157, 300
TOTAL .				·	15, 25, 000		9611,630

6 - Coats occur at years and 84 - Based on a 4% discount rate (Interest rate - Inflation rate)

THRLE S COST SUPPORY 20 YEAR BUILDON SITE 1

FINESERT	149,174,125 122,421,816	905'112'52 6A	183,644 90,647	000 611,630	6186, 194, 098 6148, 355, 601
CD67. CD678 1997 (6)		Quention 6 Pain. (Table 2) 34,511,229 25,231,508		Table 4 2, 125, 000	\$10 4 , 194,
2051 8	Construction (Table 1)	Question & M.	Closure (Table 3)	Past Closure (Table 4)	TOTAL.

e - Based on a 4% discount rate (Interest rate - Inflation rate)

COST ESTIMATE FOR 20-YEAR BUILDOUT ON PRIMARY SITE

D-EEL CONCEPT

1.5 MILLION CLOIC YARD CELLS (1004" × 1004" × 64" HIGH)

ESTIMATE IS BREED ON THE DISPOSAL OF 16 MILLION CY OF MATERIAL

TABLE 1 CONSTRUCTION COSTS SITE 1

ITEN	QUANTITY/ UNIT	UNIT PRICE (6)	TOTAL COST 1967 (\$)	VEAR(S) + CONST. COST OCCURS	INITIAL—++ CDNGT. 1987 (8)	INITIAL—40 PRESENT—440 CONST. MORTH 1967 (8) FRCTOR	WORTH WORTH CONGT. COSTS CONGT. CUSTS VRS 1-20 VRS 0-20	MORTH Congt. Costs YAS 0-20
Site Preparation	378 Acres	0001	378,000	417	13,986	12, 166	276, 787	
Campliana and and and and and and and and and	4.964.400 hrv	147	14, 713, 200		24. 388 34. 388		2	11, 317, 999
Complements of 1	15. 20 FV		462,600		17,116			30,00
Perms	S, 760, 000 bcy	I #3	17,280,000		6.79, 360		须	13,292,407
Support Buildings and Equipment								;
Odministration Building (40° z 45°)	1.800 ss. ft	8	90°06	•	90,06		•	8
Dercome! Decon. Trailer (8's 12's 40')	20	90,000	180,000	0	180,000	1.000	•	180,000
Name of Partidine (60° n 125°)	7,500 88	8	150,000	•	150,000			150,000
Sampling laboratory (20' x 20')	400 sq. ft	1 23	90,000	•	90,000		٥	8 , 98
Hawl roads site 1	31,560 ft	ន	1,578,000	6-17	•	12.166	1, 199, 872	1, 199, 672
Surface lister Control	5 UZ	4	307.085	<u>,</u>	•	12.166	233.501	233,501
Properties from 1990's 1991	-	40.000	40.000		40,000			40,000
Leachate evaporation pond (200°s 200°s 9)	: z	110,000	110,000		110,000	1.000	•	110,000
Monstoring Wells	2 5	2,000	10,000	•	10,000	1.90	•	10,000
Security Fence	19,680 1f	&	33,600	•	393,600	1.000	•	333,600
Cell Construction (1,500,000 cy cell)	10.667	5,571,588	83,422,123	6-17	5, 571, 588	12.166	40, 954, 209	16,525,797
SJB TOTAL=		•	195,214,615		67,850,039			674,279,679
Engineering design, plans and specis (10% of total costs)	total costsi		9,521,462		9,521,462			3 1 (13.6
Contingency fund (15% of total costs)		,	14, 282, 192	,	14,282,192			14,282,192
• • • • • • • • • • • • • • • • • • •			6119,018,269		831,653,692	1 _		538, 063, 522

Construction costs accur at years end.
 Initial construction costs are considered to be expenditures occurred during the first 12 months of operation (years 0 - 1).
 Initial construction costs are considered to be expenditures occurred during the first 12 months of operation (years 0 - 1).

TABLE 2 OPCARTION AND INTERNACE COSTS SITE 1

19	GPERATION INDIVIDUANCE CLISTS CLISTS	IN JINTENANCE COSTS	101AL 04N 1967 (6)	VEARS -	101A. COST	PRESENT -++ MORTH FRCTOR	PRESENT NORTH DAM
Mete transportation cost (Table 4)				97	27,189,129		18, 806, 902
Dust Suppression	40,000	F	40,000	9	720,000	12.659	306, 360
Support Buildings And Equipment Administration Personnel Decon/clean Trailers	000 's'	88 88	2, 39 5, 500	22	50,000 110,000	13.59	33,975 24,45
Haul/Access Roads	•	20,000	20,000	æ	400,000	13.59	271,800
Surface Water Control System	•	900 ří	2,000	æ	100,000	13.59	67,950
Sampling monitoring wells (quarterly)	3, 000 2, 000	•	\$ 000	8	100,000	13.59	67,950
Adeinistration Personnel	8	•	8	8	1,000,000	5	747, 450
1-51te version	25 S		\$ \$	2 5		13.134	591,030
1-Excitition forman	45.000	•	45,000	5		13.134	31,030
2-1-abovers	60,00	•	000'09	2	=	13,59	815,400
1-00/00 nersome)	8,88	•	36,000	2		12.639	405, 086
1-tealth & Safety gersonnel	200'28	,	000'2X	2		12.639	405,088
f-Field engineering support	22,000	•	35,000	=	630, 000	12.639	₩3,065
1-Scale house technician	8	•	25,000	91		12.639	316,475
2-Georite	80.00	•	000'09	8	1,200,000	13.59	815, 400
1-servetary	900'02	•	20,000	8		13.59	271,800
- 97ET					£8.511.29		625, 231, 508

6 - Cost occur at years and 88 - Besed on a 45 discount rate (Interest rate-Inflation)

TABLE 3 CLOSUME COSTS STTE 1

			į	VER 1	PRESENT-#	BOCCCUT
2011	T LINGUE	E 1500	COST	EXPENDITURE	FACTOR	H H H
Support Buildings And Equipment Decon. Personal Trailers	6		15,000	18	6. 494	1,40
Decontaminate Haul Roads Longitudinal roads on site 1 Section roads	16, 800	m m	50, 45 600, 43	22	9 4 4 4 4 4	24,877 22,212
Surface lister Control Ditch (Decon) Pond (Reove)	48, 360 1	5,000	24,180	100	0.494	11,935
	·	TOTAL•	6139,580	1 -		868, 897

- Casts occur at years and
 - Based on a 46 discount rate (Interest rate - Inflation rate)

TABLE 4 Angy Cligwe costs site 1

1184	CPERATION	CHERTION INTERNACE COSTS COSTS	107a.	YEANS-+ OF DAN	101A.	PRESENT-46 MORTH FACTOR	MESSON MORTH OF OUR
Sepport Puildings And Equipment Againstration Puilding	1,000	8	96,1	R	45,000	7.892	80°
Surface Water Control System Ditch	ı	1,000	1,900	R	30,000	7.652	7,892
Monitoring Mells	2,000	•	5,000	8	150,000	7.8%	39,460
Administration Personnel Manager (part time) Security Guard	45,000 25,000		\$ K	នន	1, 350,000	28.7 289.7	-
TOTAL.					R, 325, 000		96 11,630

0 - Costs occur at years end 0 - Costs occur at years end 0 - Costs on a 4% discount rate (interest rate - inflation rate)

TABLE S COST SLOPPRY 29 YEAR DUILDONT STE 1

MESSON -+	98,043,532	25,231,506	64,697	611,630	1157,994,178 1123,995,567
CODET. COETS 1967 (\$)	119,018,269	36,511,229	139, 580	2, 25,000	1157,994,176
costs	Construction (Table 1)	Operation & Main. (Table 2) 36,511,229	Closure (Table 3)	Post Closure (Table 4)	TOTAL

e - Based on a 4% discount rate (Interest rate - Inflation rate)

CORT ESTIMATE FOR 20-YEAR SAILABAT ON PRIMATE SITE.

9-COL. CONCEPT

MATE MILLION CORIC VAND COLLS (16.39" x 16.39" x 4.3" HIGH)

ESTIMATE IS SMEED ON THE BISHORAL OF 16 MILLION CY OF MITERIAL.

THEE 1 CONSTRUCTION COSTS SITE 1

2	GLIBITITY/ UNIT	UNIT PRICE (6)	1974. 1987 (6)	YEAR(S) → COMET. COST CICCURE	1017174_++ CD67. 1987 (6)	MESSOT -*** KORTH FRETOR	MESENT MESENT MONTH MONTH Chest, costs const. Costs VAS 1-20 VAS 0-20	MESENT MOTH CDIGT. CDGTS VIS 0-20
Bito Properation Clouring Grabbing Eartheart-cut Eartheart-fill Borns	457 acres 4, 425, 240 bcy 1, 312, 440 bcy 3, 704, 520 bcy	900 E E E	4%, 800 13, 875, 780 3, 937, 280 11, 113, 350	617	4. 25. 25. 12. 25. 12. 25.	51 57 57 52 57 57 52 57 57	363,777 9,721,028 2,883,046 9,137,806	20, 139 19, 213, 23 20, 230 20, 430 20, 303
Eugent Duildings and Equipment. Aministration Duilding (40° a 45°) Personnel Bron. Trailor (8° a 12°) Naintenance Duilding (60° a 12°) Sampling Laboratory (50° a 20°)	1,800 ss. ft 2 ss 7,300 ss. 400 sq. ft	8 8 8 8	25. 25. 25. 25. 25. 25. 25. 25.	••••	90,000 180,000 150,000 90,000		•••	4 4 4 4 8 8 8 8
Heal roods site i	27,440 ft	8	1, 332,000	417	•	12, 166	1,008,442	1, 658, 442
Serface lister Bitch Betention Fowd (250'n 250'n 15') Lacture evaporation para (250'n 200'n 5')	41,750 ft 1 m = 1	40, 000 110, 000	265, 176 40, 000 110, 000	500	0 40,000 110,000	12. 166 1. 800 1. 900	60,108 •	801,633 44,600 116,600
Monitoring Hells	3 0	2,900	98	•	10, 000	1.8	•	10,80
Security Force	21,350 15	&	427, 200	•	427,200	1.98	•	427,200 0
Call Construction (3,000,000 cy cell)	5.3 8	13, 698, 305	13,201,017	6.13	15,650,305	12.16	51,227,374	63,005,679
SID TOTAL.		. •	0114, 778, 733	l	115,661,971			991, 335, 999
Engineering design, plans and upac's (10% of total costs)	f total costs)		11,477,039	_	11,477,679			11,477,679
Contingency fund (136 of total costs)			17,216,019		17,216,019			17,216,819
Total .			6143, 473, 491	١	**, 316, 669			8120, 245, 737

 ⁻ Construction costs occur at years and.
 - Initial construction costs are considered to be expenditures occurred during the first 12 wouths of operation (years 0 - 1).
 - besed on a 4% discount rate (Interest rate - inflation rate)

29 YEAR BUILDUM FERIOR - D COCEPT RESIGN - TWEE MILLION CLOSE WAY CELLS

TROLE 2 Chedrich far Mainteones (1967) Site 1

1911	100000						
		COSTS COSTS	<u> </u>	OF OUR	1900	FACTOR	5
Ubate transportation cost (Table 4)				=	27,189,229	•	18,806,902
Dat Depression	46, 880	•	40,000	=	724,000	12.69	506, 36e
Suport Buildings find Equipment Administration Personnel Becon/class Trailors	9, 8, 98, 98,	9 9	8 8 8 8 8	88	30,000 110,000	113	2, 5 35, 5
Heal Alexans floors	•	20°,000	20,000	8	400,000	13.39	271,800
Surface lister Centrol System		\$ 000	ş,	8	100,000	13.39	67,20
Smpling andtering calls (quarterly)	4,98	•	%	8	100,000	13.55	67,980
Mainistration feromal	8	•	8 8	8		13.39	747,450
estion foresen	45,000		45,000	2 9		A	2 3 F I
1-facilities formers	추 4 8 8		8 8 8 8	≏ &		13.9	815, 408 815, 408
romel	8	•	8			12.63	405,08 100,08
6 Sefety personnel	8		8 8 8	= 3	57, 980 58, 98	15.53 5.53 5.53 5.53 5.53 5.53 5.53 5.53	43,065
1-told engineering vegots				: =		12.63	316, 475
	3	•	3	8		5	615,400
	20,00		88 '88 88 '88	2	400,000	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	271,806
TOTAL					CK, 511, 229		6C, E3, 206

 ⁻Losts accur at years and
 - beaut on a 45 discount rate (interest rate-inflation)

TABLE 3 CLOBATE COSTS SITE 1

2	VIIDAM	T 1900	701A.	YEAR-+ OF EXPENDITURE	MEMBIT ++ MONTH FRETOR	MENDIT
August bildings had Equipment Boom, Personal Trailors	3	3, 000	15,000	2	9.49	7,464
Accordanisate Heal Mode Longitudinal reads on site 1 Section reads	13, 980 15, 600	m m	41,76	22	\$ \$	80,613 819,28
Buface lister Central Bitch (Brow) Part (Barre)	41,750	5,80	98 % 98 %	22	**	10,306
	-	TOTAL.	6127, GAO		•	663,003

6 - Costs occur at years and 86 - Beand on a 46 discount rate (Interest rate - Inflation rate)

THALE 4 POST CLOSUME COSTS SITE 1

118	CONTINUES	CONTINUE MAINTENACE CONTINUE CONTIN		4588-4 97 088-		FACTOR	
Suport Buildings And Springert Aministration Building	1,000	95	96. ¹	8	\$5,000	7.892	11,63
Darface Mater Centrol System Ditch	•	1,000	1,000	8	30,000	7.88	7,692
Manitering Mells	\$ 000°	•		Я	130, 600	7.6%	33,46
Maintetration Personal Manger (part ties) Security Buard	축 편 음 음		Ą Ų	88	1, 259, 000 750, 006	7.58	255, 140 197, 200
TOTAL					62, 225, 000		811,63

Coats occur at yours and so - Based on a 4% discount rate (Interset rate - Inflation rate)

TOBLE S CUST BLOUGEV SO VEAR BUILDON BITE 1

	120, 249, 797	2,23,50	63,003	611,630	1146, 135, 939
CDGTS CDGTS 1967 (4)	143,473,491 120,249,797		127,640	8, 25,000	6182,437,460 6144,135,539
CORTE	Construction (Table 1)	Operation & Main. (Table 2) 36,511,329	Closure (Table 3)	Pack Clears (Table 4)	WIR.

e - Beard on a 45 discount rate (Interest rate - Inflation rate)

30 YEAR BUILDOUT PERIOD - P CONCEPT - 250 INCUSING CLOSIC WARD CELLS

Rocky Hountain Arsenal Task 27

Ebasco Services Inc.

Estimate of Naste Transportation Costs for a 30 Year Baildout Period

Hotes

Weste transportation costs are estimated in two parts: Man! costs (Table 2) and Loading/unloading costs (Table 3). Weste Trensportation Coats to sites 1 and 6 (bummation of tables 2 and 3) are presented in Table 4.

The first and last years of the buildest period are used for facility construction and closure, respectively.

Leading/unloading costs are uniform throughout the buildout meriod. Equipment production rates are based on 30 minute hours (835 efficiency).

Equipment production rates were estimated from the 12sd, of the Cateraillar verformance Handbook

Equipment costs are based on an hourly rental fee that includes overhead for a driver, a mechanic, fuel, maintenance and saare parts. Mental costs include a discount for both a volume flast and long term rental agreement.

Equipment rental costs were provided by EMMEDT Constructors Inc.

HOLL COSTS

Haw) costs are considered to be costs associated with the transportation of waste froe the contamination site to the land diseosal facility. Hawl costs are calculated individually for sections.

Table 1 provides an estimate of the float size and time required to transport waste from sections to disposal sites 1 & & Haul distances were measured from the center of "sections" to the centroid of the disposal site via the existing road gride. Weste volumes in sections were taken from the DALF or the Phase I Contamination Accressment Reports if evailable.

A summary of heal costs by sections are presented in table 1 for both sites 1 and 6.. Meel costs depend on heal distances and thus vary over the buildoot period. Maste material is transported in end dump hawl trucks (off-road size).

The armal "haul coats" for transportation of meste material is presented in table 2.

Equipment Specifications

End dump hawl truck (Caterpillar NSE, A-206)

. 70,00016 or 35 tons Gross vehicle seight (GWI)=138,0001b Empty vehicle weight (ENJ) = 68,0001b Payload

= 22.8 cy (struck)

Specify Specify

Estimation of heal truck production rates

Haul truck production rates are a function of the travel time to and from the centemation site and land disposal facility. The total round tripp travel time is the sum of the haul time, return time and lond/enload time.

The haul times and return times can be estimated by equations 1 and 2 derived from the Cateraillar Handbook (B.233-234).

The load/unload time is an assemed constant.

- were I is in feet, based on the BM and a total resistance of 45 (25 rolling + 25 grade) Eq. (1) Haul time (sin) = 0.22 + 4.81E-4(X)
- merre I is in feet, bused on the EMA and Of total resistance (25 rolling and -25 grade) Eq. (2) Return time (min)= 0.24 + 2.50E-4(X)

Input parameters for calculation of Table 1 and 2.

Haste placement years 26 (5 days/west-52 weeks/year)
Construction days per years
Begin waste placement at end of year 1
Load/united time (sinutes)= 2.15
Hourly 765C rental fee (8)= 64.79
Fenual waste placement rate (8CY)= 476,27

TRBE 1
Required fleet size for Transportation of waste to sites 1 and 6

895	-	86 ×	17.014		3		S ri	3	2	25	12 Kg	¥ =	¥. E	X.537	K C	2.1£	27. ¥	7.6%	27.967	3	73, OĐO	
DE00				•	•	_	_	_	•			_	_	•	_	-						
REBUINED PLEET SIZE SITE 6	•	~	•		י מ	~	~	•	₩	~	~	~	~	~	~	~	5	•	•	•		
PLEET SE					_					_						_		_	_	_		
REDUINED PLEET SIZE SITE 1	1	Q,	-	,	-	_	~		~,			•		•	••	•	•		•	,-		
PRODUCTION PRITE (BCY/MR) SITE 6	57.17	7.33	3	3	2.3	7.S	50.05	57.17	7.33	17.33	130.42	18. ×	130.42	18. X	7.53	77.53	\$.2	37.49	3.K	27.66		
PREDUCTION PROPERTY AND A SITE 1	179.45	107.57	9	2.2	2.6	212.65	8 .03	8	26.00	34.11	11.11	8 3	72.73	8.3	41.70	21.67	51.35	3	51.36	8 12		
TOTAL P TRAVEL TINE A SITE 6	16.13	3	:	4	8 8	11.91	16. 18	16.15	\$. <u>=</u>	\$. <u>:</u> :	79.7	8	7.67	8	11.91	11.91	£. 5	3.5	24.67	33,15		
TROWEL TIME 1	\$ 15	5	3 :	3	 39 .:.	¥.4	9.45	3	12.63	17.07	12.87	17.11	12.70	17.10	8.14	17.87	17.91	R	17.91	×		
RETURN TINE (NIN) T SITE 6	7		3 3	S.	5.73	3.12	4.45	3,	3.13	2.13	8.	8	8.	97	115	7 15	5.3	7.00	2.0	2.7		
RETURN TIME (MIN) SITE 18	9		3 :	3.67	3.67	0.71	2.5	2.5	7	4, 73	2	1.7	1.37	7	E 3	3	8	2	8	7.63	!	
HALL TIME (MIN) SITE 6	8	3 2	2 ;	₹. ~	10.06	2.76	2	8	5.78	2	8	*	8	1 X	×	3.76	10.0	~	9	7	?	
HALL THE (MIN) SITE 19	-	: F	3	6.	6.8	ส <u>.</u>	12.4	4.27	. 4		2	£ 87			P	2.3	. o.			2 4	ž	
HOLE DISTINCE SITE 6	is an		11,11	8	22,120	11,520	16.840	15.80	9	3	96	4 5	96	42.4	=	5	8	1 5	3	3 5	R	
HALL DISTANCE I SITE 18		3 ;		13,700	13,700	2,100	9		2 5		94. 61		200		2 × ×			8		P	R G	
WETE VOLUME (SCY)	2 000	2000	2 2 3 4	2, 185, 800	1. 715, 800	47.300	200	8	}	3 5	3		90° 63°	90 kg	142,000	9, 60			3 3		3	
9ECT 10N		6 :	Ą	_	•	· K	3 ¥	3 8	5 5	2 €	2 5	3 8	6 =	3 8	y •	7	9 5	4 :	-	n •	• '	
CLEAN UP PRIDRITY		-	N	m	•	•	,	9 -	•		- :	2 :	= \$	≥ :	2 :	<u>.</u>	2 :	2 5	= :	2 :	2	

30 YEAR BUILDOUT PERILID - D CONCEPT - 250 THOUSING CLIBIC YARD CELLS

TABLE 2 CHALICL COSTS SITES 1 & 6

0 38, 608 38, 888 38, 888	1 🖺
	199,419
205, 290 222, 383 303, 819	91,407,441
0.368 0.368 0.368 0.207	,
273,389 648,361 1,151,015	KS, 070, 103
571,932 641,212 911,064	\$1,714,261
3 8 8 8 8	13TA.
	571,532 273,389 0,3607 206, 641,212 646,361 0,3468 222, 911,064 1,151,015 0,3335 303, 0 0,2807

LOGO/UNLOGO COSTS

Load costs are costs associated with placement of waste in haul trucks.

Unload costs are costs associated with placement and compaction of the waste at the land disposal facility.

Load costs are based on a dozer to windrow waste material and a laader to place the waste in a haul truck.

Placement costs are based on a dozer and motor grader to move, level and compact the material at the land disposal facility.

Load/unload costs are proportional to the waste placement rate and therefore are uniform. A summary of annual load/unload costs are presented in table 3.

Equipment Specifications

90° **	58,000 270 3	82 83 181
Dozer (Caterpillar D76, p. 15) BAU(1b)= Flywheel power (hp)= Universal blade	Loader (Caterpillar 90C, p.287) BM(1b)= Flycheel power (hp)= Backet size (cy)=	Motor Grader (Caterpillar 126, p. 79) 694/1b)= Flywheel power (hp)= Standard 10* blade

CHARLEL LONDANALOND CUSTS -+ THE 3

		HOLELY			YEARS		MESENT	
ENUMBIT	AC.	PROD. BOTE (ICY)	HOURLY RENTAL (6)	RENTAL (6)	OFERNTION	0.00 (a) (b) (b) (c) (c) (c) (c) (c) (c) (c) (c) (c) (c	FACTOR	MESENT
-#22		98	3	254,890	1-38	7,134,460	16.663	4,245,722
100		8	*	25,36	8 5	6,304,557	16.663	3,754,287
F 45	-	4	8	**	1-8	1,648,192	7	38 0, 65 1
Total=				6538,970		615,091,149	•	98, 980, 650

- e Lead/unload costs are the same for sites 1 and 6 e e Eised on 8 hour days 260 days per year

TABLE 4
MASTE TRONSPORTATION CUBTS
FOR
SITES 1 AND 6

STRE 1 STRE 6 STRE 6 STRE 6 CUSTS CUSTS PRESENT CUSTS PRESENT EIPENOTINE 1907 (4) MORTH 1907 (4) MORTH

HALL COSTS (TRBLE 2) 1,714,251 1,407,441 5,070,103 4,199,419 LONG/UNLIND (TRBLE 3)-+ 30,182,298 17,961,701 30,182,298 17,951,701

TUTAL * 131, 895, 558 619, 369, 142 155, 252, 401 422, 161, 120

+ - A COMPENSATION FACTOR IS ABLED FOR LEVEL B WANCER PROTECTION

30 YEAR BUILDOUT PERICO - 8 CONCEPT - 250 INCUSAND CLOIC YARD CELLS

COST ESTINGTE FOR 30-YEAR BUILDOUT ON PAINGAY SITE

P-CELL CONCEPT 250, NO CLORIC 1980 CELLS (636' x 636'x 43' MIGH) ESTINATE IS DASED ON DISPOSAL OF 16 MILLION CY OF WITERIAL

TABLE 1 CONSTRUCTION COSTS SITE 1

	QLIMETTY/ UNIT	UNIT PRECE (6)	1019. CDST 1947 (8)	VEAR (S) -+ CONST. COST ACOMS	1917178, +++ CD651. 1967 (8)	MESENT -+++ MONTH FRETOR		MORTH MORTH CONST. COSTS CONST. COSTS VISS 1-29 VISS 0-29
Site Preparation	10	9001	969	6-2	24.657	15.98.3	397,292	42, 149
	1,7 (%)	~	9.531.360		340,406		ď	₽.
Editional States	3 647 AMO bez	. ~	11.002.200		392,940			
Bers	11, 366, 640 bey	, m	34,099,920	6-27	1,217,854		_	20, 642, 819
Support Buildings and Equipment							•	:
Deministration Building (60' n 20')	1.200 sa. ft	8	000,09	•	900			8
	2	\$0,000	270,000	0	270,000	.000		270,000
Maintenance Building (60° m 100°)	6,000 es	8	120,000		120,000	1.000		150,000
_	400 sq. ft	S	90,000	0	90,000	7.000	•	8
Hewl roads site 1	93,000 ft	S	4,650,000	12-0	•	15.983	2, 72, 62	2, 752, 628
Surface Water Control	\$ \$ \$ \$	•	115	5	•		Ş.	140
Pitch	11,500 11	9	3 5		40.00			40,000
Leachate evaporation pond (200° x 200° x 5)	: :	110,000	110,000	•	110,000		-	110,000
Monitoring Wells	2	2,000	10,000	•	10,000	1.00	•	10,000
Security Fence	27,120 1f	æ	542,480	0	542,400	1.000	•	542, 400
Cell Construction (250,000 cy cell)	3	1, 673, 490	1,673,490 107,163,360	12-0	9,099,023	15.963	54,014,938	67,113,961
9.0 TOTAL:		•	6169, 069, 560	١	812, 317, 480			6105, 108, 918
Engineering design, plans and sear's (10% of total costs)	total costsi		16,906,958	_	16, 906, 958	_		16, 906, 558
Contingency fund (15% of total costs)			25, 360, 437		25, 360, 437			25, 360, 437
1 1 1			6211.336.975	٠	564, 584, 875			9147, 376, 313

Construction costs accur at years end.
 Initial construction costs are onsidered to be expenditures occurred during the first 12 months of operation (years 0 - 1).
 Based on a 44 discount rate (interest rate - inflation rate)

TABLE 2 Operation and walktowance costs site 1

<u>a</u>	OFERNTION COSTS	IN INTENDACE COSTS	TOTAL Odin 1967 (6)	YEARS-4 OF OAR	TOTAL COST	PRESENT -++ NORTH FRCTOR	PRESENT MURTH OAN
Waste transportation cost (Table 4)		,		85	31,696,556		19,369,142
Dust Suppression	40,000	ı	000'0	8	1, 120,000	16.63	665, 200
Support Buildings And Equipment Administration Personal DeconClean Trailers	2,000 15,000	SS SS	4. R	<i>ጽ</i> ጽ	75,000	77.29 29.7.7	43,230 95,106
Haul/Access Roads	•	20,000	20,000	R	600, 000	17.292	345, 840
Surface Hater Control System	•	\$,000	\$,000	R	150,000	17.39	36 , 46 0
Sampling monitoring wells (quarterly)	5,000	•	2,	8	150, 000	17.29	98,460
Adeinistration Personnel							;
1-Site Naname	50°	•	8	8	1,650,000	2.28	25. 26.
1-Construction foresan	45,000	,	45,000	R	1,350,000	17.29	778, 140
1-facilities foreign	45,000	•	45,000	8	1,350,000	17.29	778, 140
2-4 abovers	900'09		000'09	R	1,800,000	17.2%	1,037,520
1-00/0C personne)	90° A	•	900°24	æ	896, 000	16.63	532, 160
-thus the Safety mercomes	200	•	200°24	8	896,000	16.63	3%, 160
1-Field engineering support	98 14		25,000	8	980,000	16.63	28 5, 050
1-Crale bases technician	8.12	•	8	18	700,000	15.63	415, 750
2-Carusto	90.09	•	000'09	8	1,800,000	17.28	1,037,520
1-secretary	50,000		20,000	R	900'009	17.28	345, 840
# 4 2001					M6, 178,538		127,681,778

6 - Costs occur at years end 84 - Based on a 4% discount rate (Interest rate-Inflation)

TABLE 3 CLUSUME COSTS STIE 1

		*	2	¥694	PRESENT-#	ta Capata
1101	AT ETNOTO	1502 1502	101 F	EXPENDITURE	FACTOR	HORTH
Support Buildings And Equipment Decon, Personnel Trailers	3	5, 000	15,000	8	6. 334	\$,003
Decontaminate Heal Roads Longitudinal roads on site 1	47,640	m	5. 86. 86.	₹ ₹	9.34	47,664
Section roads	OM fc	•	Š		\$	e e e e e e e e e e e e e e e e e e e
Surface Water Control Ditch (Decon)	140,640		02,00	ন্থ	0.334	23, 452
Pond (Remove)	-	ş, 000	y, 000		0,334	1,668
	_	TOTAL	\$278,240			992, 793

6 - Costs occur at years end 86 - Besed on a 45 discount rate (Interest rate - Inflation rate)

TABLE 4 PUST CLOSUME COSTS SITE 1

						PRESENT-46	PRESENT
#GLI	0458410N 0051S	OPERATION MAINTENANCE COSTS COSTS	TOTAL DEM	YEORIS-4 Of DAM	PETE PETE	MORTH FACTOR	MORTH OF
Support Buildings And Equipment Adennistration Building	000'1	95	1,500	я	45,000	5.381	1,997
Surface Mater Control System Ditch	,	1,000	1,000	R	30,000	5.333	5,333
Monitoring Mells	3, 000	•	\$,000	8	150,000	5.331	% 83
Abainistration Personnel Monager (part time) Security Board	25,000 15,000		25, 50 50, 50	88	750, 000 450, 000	5.331 5.331	131,275 79,965
TOTAL				•	11, 425, 000		62 1,23

e - Costs occur at years and ** - Based on a 4% discount rate (interest rate - Inflation rate)

TABLE S COST SUMMORY 30 YEAR BUILDOUT SITE 1

	CO	
	C05TS	+-INGS3M
COSTS	1967 (8)	E E
Construction (Table 1)	211,336,975 147,376,313	147,376,313
Operation & Main, (Table 2) 46, 178, 558	46, 178, 558	27,681,778
Closure (Table 3)	278,240	92, 733
Post Closure (Table 4)	1,425,000	23,23
TOTAL.	\$259,216,773 \$175,404,106	8175, 404, 106

e - Based on a 45 discount rate (Interest rate - Inflation rate)

COST ESTIMATE FOR 30-YEAR BUILDOUT ON PRIMARY SITE

-CEL CONCENT

ONE MILLION CLOIC YARD CELLS (1004' X 1004' X 43' MIGH)

ESTIMATE 18 MRED ON THE BISHOURA. OF 16 MILLION CY OF WHERIAL

TABLE 1 CONSTRUCTION COSTS SITE 1

	ALBECTITY, UNIT	UNIT PRICE (6)	101A. COST 1967 (4)	YEAN(S) -e CONST. CUST OCCURS	1M1T1AL-++ CDIGT. 1987 (6)	MESENT-444 MORTH FACTOR	MESENT PRESENT LUGITH LUGITH CDIGT, COSTS CONGT, COGTS YNG 1-29 YNS 0-29	MERBIT MOTH CONST. COSTS VIBS 0-29
Site Properation Clearing Brubbing	227 acres	9001	25 XX		18,014	55 52 58 52 58 52	300,709	319,223 6,771,657
Earthmark-cut Earthmark-fill Bara	4,721,100 tey 673,660 tey 3,932,930 tey	, .	2,024,800 11,838,70	ìì	4 5 2 4 9 2	: 3: 3: 3: 3: 3:	1,156,91	
Suport Buildings and Equipment Administration Building (60° n 20°) Pursonnel Bucan. Trailor (8"n 12"n 40") Maintenance Building (60° n 100°) Sampling Laboratory (20° n 20°)	1,200 m, ft 6,000 m, ft 400 m, ft	\$ \$ & %	66,000 1,000 1,000 1,000 1,000 1,000	0000	66,000 270,000 124,000 99,000	989 989 999 999 999 999 999 999 999 999	0000	270,000 120,000 120,000
Heal reads wite 1	40°260 ft	8	2, 028, 000	Ĩ	•	15.963	1,200,501	1,200,301
Surface Matur Centrel Bitch Betantion Pond (250° x 250° x 15°) Lastiete evaporation pond (200° x 20° x 5°)	# 1 1 3 #	40,000 110,000	4.55, BEA 40, 600 110, 600	60	60,000 110,000	1.963	25. 0 0	25,015 40,000 110,000
Manitoring Wells	8 %	2, 600	19,000	•	10,000	1.80	•	10,000
Security Force	22,200 14	8	444,000	•	44,900	1.98	•	444,600
Call Comstruction (1,000,000 cy call)	ž.	5,636,339	90, 185, 38A	5	9,099,023	15.90	44,000,241	57,099,264
9.8 TUTAL.			9119, 359, 300	٠.	#11, 15K, 446			675, 214, 448
Engineering design, plans and spec's (10% of total costs)	f total costs)		11,936,930		11,936,930			11,936,530
Contingency fund (155 of total coats)			17,986,355	!	17,905,395	•		17, 905, 355
Total -		. •	6149,211,625	۱	840, 998, 771			\$165,00K,773

 ⁻ Construction costs occur at years and.
 - Initial construction costs are considered to be expenditures occurred during the first 12 months of operation (years 0 - 1).
 - Beand on a 4% discount rate (Internst rate - inflation rate)

TABLE 2 OPERATION AND WATHTENANCE CLISTS SITE 1

	COFENATION COSTS	OPENATION MAINTENANCE Costs costs	101AL 04H 1967 (6)	Y5985-1	TOTAL COST	PRESENT -++ MORTH FRETOR	MESSEN MONTH COM
thate transportation cost (Table 4)				8	31,656,338		19,369,142
but Supression	40,000	•	40,000	8	1, 120, 000	16.63	902,200
Support Delidings And Equipment Amenistration Arrannel Deconcion Trailors	900 v. 900 v. 900 v.	8 8 8	95 st	88	75,000 163,000	17.29 17.29	43,230 35,136
Heal/Access Roads	•	90°92	8	R	600,000	17.29	345,840
Surface Hater Centrol System	•	3, 900	F 000	8	130,000	17.29	3
Supling anitoring wells (quarterly)	2,000	1	80 %	R	130,000	7.C	7
Abinistration Personnel	¥	•	8	8		5	Ş
1-Contraction forms	8 4	•	4	3 8	70,000	200	1
1-facilities formen	45,000	•	45,000	角	1,350,000	17.23	778,140
2-Laborara	900	•	3	R	1, 800, 000	17.29	1,637,528
1-GA/GC personnel	200'24	ı	86 M	2	936,000	16.63	SE, 160
1-Health & Safety personnel	20,00	•	86,98	#	976, 9 00	16.63	991 '2K
1-Field engineering support	88 X		80 A	2	980,000	14.63	382,680
1-Scale house technician	8	•	8	2	700,000	15.63	25 P. S. S.
2-Security	90,03	•	98	8	1,800,000	17.28 27.28	1,037,520
1-secretary	98 g	•	80,000	8	600,000	17.28	34 PE
TOTAL					946, 178, 358		11,681,778

6 - Coots occur at years and 86 - Besed on a 45 discount rate (Interest rate-Inflation)

TABLE 3 CLOBUSE CUSTS BITE 1

2	TILLE	UNIT 1300	100 100 100	VESS-+ OF EXPENDING	PRESENT-44 LOTTN FRCTOR	PRESENT
Support Phildings And Equipment Decen. Personnel Trailors	m	98 *s	15,000	8	9.33¢	5, 003
Decentarinate Hast Roads Longitudinal roads on site 1 Dection roads	28, 104 15, 800	n m	66, 312 45,000	88	5 5	25, 15 20 , 21
Serface libter Centrel Bitch (Becon Pand (Becon)	3-	. 000 t	¥, 14,	នន	6. U.S.	95, ;; 648, ;
	F -	TUTA	110,010		•	961,245

- Costs accur at years and
 - Decad on a 46 discount rate (Interest rate - Inflation rate)

THREE 4 POST CLOBUNE COSTS SITE 1

						•	MENE
	COURT ION	CHENTION INTINTEDIACE CHETS CHETS	E S	4000			
Support Buildings And Equipment Abundahration Beilding	1,000	95	1,30	Я	\$5,00	2 20	7,937
Surface Mater Centrol System bitch	•	1,00	1,000	8	98'98	r g	ğ
Monitoring Wells	\$		\$ 8	8	150,000	E S	Ą
Abbinistration Personnel Manger (per time) Security Baard	25, 200 15, 600	٠.	42 88 88	**	35, 25 55, 28	ÄÄ	12.22 23.25
TOTAL - Couts ground of many at				•	11, 425, 600		120 KG

o - Casto occur at years and to - based on a 45 discount rate (Interest rate - Inflation rate)

THRILE S COST BLOWERY 30 YEAR DULLIOUT SITE 1

COUST. CASTS PRESENT 1967 (6) MARTIN	144,811,625 165,635,773	110 20 44,174,338 21,481,778	163,644 61,245	1,45,000 551,253	
State	Construction (Table 1)	Operation 5 Naire (Table 2) 46,178,558	Closure (Table 3)	Aust Clemere (Table 4)	

a - Beent on a 45 discount rate (Interest rate - Inflation rate)

39 YEAR BUILDEUT FERIED - D CONCEPT - ONE & ONE HALF ATTLLION CLOIC YAND CELLS

COST ESTIMATE FOR 30-YEAR BUILDBUT ON PRIMATY SITE.

9-EBL CONCEPT

GRE & CHE HALF MILLION CABIC YARD CELLS (1004" IL 1004, IL 60" HIGH!)

ESTIMATE IS DATED ON THE DISPOSAL OF 16 MILLION CY OF WATERIAL.

THRLE 1 CONSTRUCTION COSTS SITE 1

1881	SECULTY, UNIT	LINIT PRICE (6)	1918. (2051 1967 (6)	VERM (S) -+ COMET. COST (ECCURE)	INITIAL—40 CDBT, 1987 (8)	MESENT -*** KORTN FACTUR	MESENT METT. CORTS VIG 1-29	MONTH MONTH CDGT. COSTS VNE 0-29
Site Preparation Clearing Orebing Extinuit-cut Earthmark-fill Paras	# 178 erre 74 606 408 ft 191 509 609 ft	90 m m m	378, 000 14, 713, 200 462, 600 17, 284, 000		13.50 15.47 15.18 15.18	以以以以	20 12 5 20 12 5 21 12 5	12.5.4.4.4.4.4.4.4.4.4.4.4.4.4.4.4.4.4.4.
Support Daildings and Equipment Absinistration Dailding (60° x 20°) Personnel Becon. Trailor (6° x 20°) Haintananes Dailding (60° x 100°) Sumpling laboratory (20° x 20°)	# # # # # # # # # # # # # # # # # # #	8 8 8 E	66,053 600,053 600,051	0 0 0 0	32 55 38 58 38 58 38 58	000 11 000 11 000 11 000 11	• • • •	44 50 50 45 50 50 45 50 50 45
Heal roads site !	31,550 73	8	3,578,900	ĩ	•	15.90	504,116	8 7,18
Berface Mater Canhrol Mitch Betention Pond (220°s 260°s 15°) Leachalte evaporation pend (200°s 200°s 5°)	# # I	40,000	107, 086 40, 080 119, 000		46, 000 116, 000	A	101,78 • •	181, 784 40, 600 119, 600
Manditoring Holls	8 00	2,000	19,880	•	16,000	1.8	•	10,01
Security Fonce	19,640 17	8	333,600	•	35	1.90	•	33,600
Call Construction (1,300,000 cy cell)	10.667	5,571,380	3,42,13	4	3,055,083	15.90	25,755,155	38, 694, 238
9.0 TOTA.		•	PSC, 244, 615		911, 359, 259			161,018,731
Engineering design, plans and spec's (10% of total costs)	f total coets)		3,88,62		3,321,462			3, 281, 462
Contingency fund (15% of total costs)			14,286,692		14,286,672			14,286,692
Total •			1119,000,759		425, 175, 413			864, 865, 865

 ⁻ Construction costs occur at years and.
 - Initial construction costs are considered to be expenditures occurred during the first 12 months of operation (years 0 - 1).
 - bead on a 46 discount rate (Interest rate - inflation rate)

THULE ? OFEINTION FIRE MAINTENNESS COSTS SITE 1

	OFFICE		410 4		TOTAL	MENDIT ++	
ITEN	CUSTS COSTS	250	1987 (6)	OF 081	COST	FACTOR	5
Whate transportation cost (Table 4)	,	٠	•	25	M, 6%, 338	•	19, 369, 142
but Supression	46, 080	•	4,00	8	1, 150, 000	3,50	665,200
Support Duildings And Equipment Alministration Personnel Decevicions Trailors	98 4 4	95 S5	86 87 87 87	88	사 88 원	2. 2. 2. 2.	2 R
Heal Access fleets	•	20,000	00 '02	A	000'009	17.2%	345,040
Surface Mater Control Bystes	•	4. 98	\$ 000 Y	8	150, 600	17.73	¥
Sampling anothering nalls (quarterly)	\$ 900	٠	\$,000	8	130,000	17.00	3
Alainistration Paraceral	8	•		8	1.630.000	27.28	98. 98.
1-Construction former	\$ 90	•	900	, ,		17.28	776,188
1-facilities formes	4	•	45,000	吊		2. CE	72,16
Staterers	900'09	•	60,000	8		17.28	1,637,320
1-GA/IE personnel	8 2		88 Z	22	_	15.63	52, 52 51, 52
Libelth & Sefety sersome!	18 30	•	8 2	8	Ī	15.62	31, SZ
1-Field engineering support	8 X		25, 880	20		15.63	580, 650
t-Beate house technician	8 1	•	8	ਲ	• -	15.5	415,738
2-facerity	3	•	60,000	8	=	17.22	1,037,320
1-morntary	80,000	•	8,60	R		 2.2	345,040
- 3/5					946, 178, 358		67, CB1, 778

- Dats occur at years and
 - Besed on a 45 discount rate (Interest rate-Inflation)

THERE 3 CLABUTE CASTS STITE 1

				AEST.	PRESENT -+	
	CLEATIV	COST TENT	4 FEB	OF EIFERTHE	MDRTH FACTOR	
Appart Buildings And Squippent Boon, forsomed Trailors	m	8,000	15,000	83	AT 0	\$ 60
Dentainate Hal Rada Longitudinal rada on site 1 Button rada	16, 800 15, 600	m m	왕 8 8	ສ ສ	44	
Surface latter Centrol Sitch (Secon) Para (Nasove)	ok 4	- 08	¥. 4.	8 8	***	40.4
	-	TOTAL-	9133,380		•	9#6,350

e - Costa occur at years and so - Based on a 4% discount rate (Interest rate - Inflation rate)

TABLE 4 FOST CLOBURE COSTS SITE 1

ē	OPENNT ION CLISTIS	OPERATION MAINTBUNCE COSTS COSTS	1918 198	VENE -		MERENT -40 MONTH FACTOR		
Suport Brildings And Equipment Amenistration Building	990,1	8	96,1	R	8,00	5.331	7,997	
Burface Mater Centrol Bystem Hitch	•	1,800	1,000	8	90 'A	2.33	12.4	
Stationing Utils	900 °S	,	80 ¥	8	130,000	in s	1 5	
Mainistration Personal Penager (sert time) Security Seart	25, 20 20, 21		4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	88	730,000 450,880	5 E	12 12 12 12 12 12 12 12 12 12 12 12 12 1	
107AL.				•	es, 423, 000		132 1528	

- Costs occur at years and
 - Beand on a 45 discount rate (Interest rate - Inflation rate)

PRINTED DIS GLOSATA PRE A

TABLE S COST BLOOMY 30 YEAR BUILDON SITE I

MENBIT -	ON, BES, BES	27,541,778	ş,	22,22	1112, 011, 435
CD61.	119,055,769 64,629,885	6,171,33	139,380	1, 425,000	9166, 730, 507 6112, 811, 435
\$1900 \$1.000	Construction (Table 1)	Operation 5 Nain (Table 2) 46, 178, 538	Closure (Table 3)	Past Closure (Table 4)	

t - Beard on a 45 discount rate (interest rate - inflation rate)

COST ESTIMATE FOR 30-YEAR BUILDOUT ON PRINKIN SITE

PLELL CONCEPT

THREE MILLION CURIC HARD CELLS (1639° X 1639° X 43° HIGH)

ESTIMATE IS BASED ON THE RISPOSAL OF 16 MILLION CY OF WATERIAL

TABLE 1 CONSTRUCTION COSTS SITE 1

181	BURRITY/ UNIT	UNIT PRICE (6)	TOTAL COST 1967 (6)	YEAR(S) -+ Const. Cost occurs	INITIOL—88 CD657. 1987 (6)	INITIAL—48 PRESENT—486 CONST. MORTH 1987 (8) FRCTOR	MESENT MONTH CONST. COSTS YRS 1-29	PRESENT PRESENT MORTH MORTH CONST. COSTS CONST. COSTS YYS 1-29 YYS 0-29
Site Preparation	A97 arres	0001	008 APA	6-97	17.743	15.983	243.584	100 TO
Carthagas and working	- 12 2 2 2 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	~	11 275 720		674. 133		7.578.065	A. 652. 198
Carthenate-fill	1 212 th0 bry	, ~	1 437, 250	6-9	140,619		2,247,507	2.346.125
Berss	3, 704, 520 bey	. ~	11,113,560		396, 913		6,343,858	6,740,771
Support Buildings and Equipment								
Administration Duilding (60' x 20')	1,200 m. ft	8	900'09	•	60,000	1.000	•	66,000
-		30,000	270,000	0	270,000	1.00	•	270,000
Maintenance Building (60° x 100°)	6,000 68	8	120,000	٥	120,000		•	120,000
Sampling laboratory (20' x 20')	400 sq. ft	83	90,000	•	90,000	1.00	•	90,00
Haul roads site 1	27,840 ft	8	1,392,000	0-57	•	15.983	B24,012	E24, 012
Surface Water Control						,		
Ditch	41,760 ft	9	265,176	•	•	_	136,974	_
	2	000 0	000		90,000			90,00
Leachate evaporation pord (200°H 200°H 3°)	3	110,000	00,000	•	10,000	8.	•	110,000
Monitoring Wells	2 10	2,000	10,000	•	10,000	1.90	•	10,000
Security Fence	21,360 11	8	427,200	۰	427,200	1.90	•	427,200
Cell Construction (3,000,000 cy cell)	5.3	15,618,305	63, 201, 017	6-27	9,099,023	15.903	43, 865, 636	85'884'E3
SUB TOTAL.			1114, 808, 793		111,255,630			172, 335, 267
Engineering design, plans and spec's (106 of total costs)	iotal costsi		11,480,879		11,480,679			11, 480, 879
Contingency fund (15% of total costs)		'	17,221,319	,	17,221,319			17,221,319
Total =		•	\$143,510,991	ı	639,557,628			\$101,257,465

Construction costs accur at years end.
 Initial construction costs are considered to be expenditures occurred during the first 12 months of operation (years 0 - 1).
 Based on a 4% discount rate (inferest rate - inflation rate)

TABLE 3 CLOSUME COSTS STTE 1

170	DJAN17Y	UNIT T203	18 TP.	YEAL-4 OF EXPENDITURE	PRESENT-44 LIDRIN FRETION	MESENT WONTH
Support Nuldings And Equipment Decon. Personnel Trailers		5,000	15,000	83	6. 334	F 83
Decontaminate Maul Roads Longitudinal roads on site 1 Section roads	13,920	m m	41, 750	នុខ	6. 134 134	13,997 15,00 6
Surface Mater Control Ditch (Decon) Ford (Remove)	41,760	1 5,000	20,680 5,000	# #	**************************************	6, 98.3
	•	TOTAL.	\$127,640		•	942,568

e - Coste occur at years end ee - Besed on a 45 discount rate (Interest rate - Inflation rate)

TABLE 4 Agst Closume costs Site 1

1911	CPERATION COSTS	OPERATION MAINTENANCE COSTS COSTS	ATOT PER PER PER PER PER PER PER PER PER PER	YEARS-+ OF DAM	ATOT HARD	PRESENT-44 MORTH FRCTOR	PRESENT LICRTH OF DAM
Support Buildings And Equipment Administration Building	1,000	95	1,500	8	45,000	5.33	1,997
Surface Hator Control System Bitch	,	1,000	1,000	Я	30,00	S. Bi	5.33
Monitoring Wells	900 %	•	\$,000	R	150,000	5.33	25, ESS
Idainistration Personnel Manager (part time) Security Guard	25,000 15,000	• •	25, 900 41, 900	88	750,000 \$50,000	5 Bi	133.275
1019."				•	11, 425, 000		121,23

e - Costs occur at years and

TABLE 5 COST SUMMEN 30 YEAR BUILDOUT SITE 1

COBIS Construction (Table 1)	CONST. COSTS 1967 (4)	COIST. COSTS PRESENT—9 1967 (4) MORTH 143. 510. 991 101. 257. 465
Operation & Main. (Table 2) 46, 178, 558	46, 178, 558	27,681,778
Closure (Table 3)	127,640	42,568
Post Closure (Table 4)	1, 425,000	23,23
TOTAL	6191, 242, 189 6129, 235, 033	8129, 235, 033

e - Based on a 4% discount rate (Interest rate - Inflation rate)

THBLE 2 Operation and introduce costs site 1

191	OPERATION COSTS	OPERATION INTENDACE COSTS COSTS	1978. 044 1967 (\$)	YEARS—* Of Oen	TOTAL	PRESENT -++ MORTH FRETOR	PRESENT MIDRITH CALIF
Maste transportation cost (Table 4)				83	31,696,556		19,369,142
Dust Suppression	40,000	•	4 0,000	83	1, 120, 000	16.63	665, 200
Support Buildings And Equipment Administration Personnel DeconCelean Trailers	9,000 900 900	88	ડ જ જ	8 8	75,000 165,000	17.292 17.292	43,230 95,106
Haul/Access Roads	•	20,000	20,000	R	600,000	17.28	345,840
Surface Mater Control System	,	2,000	5,000	Я	150,000	17.2%	96, 460
Sampling monitoring wells (quarterly)	5,000	ı	\$ 000 \$	8	150,000	17.292	96 , 16 0
Administration Personnel	1	,	\$	\$	000 053	27.28	98.080
1-Site Manager	88. K	• •	25,000	3 8	1.350.000	28.73	
L-Construction Towns	900 54	,	45.000	8	1, 350,000	17.292	778, 140
2-1 showing	900'0	'	60,00	8	1,800,000	17.292	
1-fb/ff reserved	200.2	•	32,000	**	896, 000	16.63	
1-Health & Safety mercome	000'2	,	35,000	Æ	896,000	16.63	
-Field engineering support	98 14	,	, K	€		16.63	
1-Costs being technician	8	1	8	8	700,000	16.63	415,750
O-Carried a	90.09	•	90,00	8	=	17.292	<u>-</u>
1-servetary	900,03	,	30,000	8	_	17.2%	
- 9F0T					946, 178, 558		927,681,778

Eosts occur at years and
 Based on a 4% discount rate (Interest rate-Inflation)

TABLE I SUPPORY OF CELL CONSTRUCTIONS COST FOR D CONCEPT DESIGN

1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	20,000 12,000 12,000 13,000 14,000 14,000 14,000 16,000 17	1,000,000 1,500,000 1,000,000 1,500,000 33,004 33,173 103,722 35,937 37,251 974,877 970,251 974,877	ZE (CY) 1,500,000	3,000,000	UNIT PRICE	080 '082	CEL S17E (CY)	E (CY) 1,500,000	3,000,000
ys. No. No. Sand 12° Clay burrier 36° Sand 12° HOVE Geo-net Filter Fabric Soil Cap 36° Revegetation	25, 25, 25, 25, 25, 25, 25, 25, 25, 25,	891, 697 33, 604 103, 724 37, 722 970, 861							
Sund 12" Clay barrier 36" Clay barrier 36" Sand 12" Sand 12" Fitter Fabric Soil Cap 36" Revegetation	207 LES 208 LE 208 LES 208 LES	991,997 103,724 103,724 35,726 135,077							
Sand 12° Clay barrier 36° Sand 12° Sand 12° HDYE Geornet Filter Fabric Soil Cap 36° Revegetation	10 1 10 1 10 1 10 1 10 1 10 1 10 1 10		A16 714	2 418 907		45,647	160.397	161.298	451.407
Sand 12° Clay barrier 36° Sand 12° HOFE Geornet Filter Fabric Soil Cap 36° Revegetation		4 2 14 18 18 18 18 18 18 18 18 18 18 18		X 2					-
Clay barrier 36" Sand 12" HDPE Geornet Filter Fabric Soil Cao 36" Revegetation	166 fc2 114 fc 385 fs2 385 fs2 385 fs2 385 fs2 385 fs2	103, 724 35, 75 136, 079 136, 081	2,2	£, 25	37.8	15/20	25 66		
Sand 12° HDFE Geornet Filter Fabric Soll Cap 36° Revegetation	166 ft2; 114 ft. 385 fs.2; 385 fs.2; 385 fs.2; 385 fs.2; 385 fs.2;	77, 72, 970, 781 981, 782	104,453	287,540	8.8	247,097	£ 62		-
HDYE Geornet Filter Fabric Soil Cap 36* Revegetation	28 28 28 28 28 28 28 28 28 28 28 28 28 2	970,261	JA, 955	97,610	12.80	131,230	83,83 83,83	431,945	1, 173, 718
Georat Filter Fabric Soil Cap 36* Revegetation	286,286 286,386 28,451 28,451	970.261	974,877	2.651, 114	6.3	222, 439	727,6%	731, 156	1,986,335
	385 '852 124 '87 168 '128		974,877	2.651.114	0.17	50, 420	15, 2	165, 729	450, 689
	34,471 32,697	970, 261	974.877	2,651,114	0.18	53,385	174,647	175,478	477,200
;	323,897	110,533	111.046	230.065	4 .80	137, 885	442, 134		1,1%,230
_ ;		CM - 610 .1	1.023.959	2,729,009	0.0	9,069	28,542		76, 496
4.0		2				.		•	
Substitute and the substitute an					-	15, 600, 15	81, ISI, 226	63, 372, 115	19, 235, 339
Cover Sys.									
Filter Fahric	260.74	904, 908	870,295	2,542,634	0.18	46, 934	162,003	156, 653	
	260, 744	904.908	670,295	2,542,634	0.17	\$2, X	153,634	147,950	
	260,744	906.508	870,295	2,542,634	0.73	195,358	676, 641	652, 721	1,906,976
-CI PM	9,670	33,528	, 25.	\$.58	12.00	116,042	402,337		1, 130, 216
5 Clay barrier 36" cy	30,135	102,637	96,616	285,962	9 .00	241,082	821,093		2,287,694
		•					900	20 11: 00	44 214 MA
SUB TOTAL:						24.5 Mg	WC, C16, BC6	K, 13, X8	/00 tallo to
System							;		;
1 HDPE Pige (4") 1f	5,45	8. 8.	8 8	£,43	ક જ	13,628	8,00		21,00
Collection Sumo	3	1.72	1,722	9	ક્ર ત		906,4		15,501
3 Clean outs es	•	£1	. 13	8	750.00		9. 150		21,000
SUBTOTAL *						919, 396	864, 545	84,545	1547, 339
TOTAL					•	61 672 490	65 K K 540		5571. SAN 815. 690. 205

..dd Hai.. 01-Jun-87

Ebasco Services Incorporated Rocky Rountain Arsenal - Task 27

Material Quantities for B-Concept Design

Side slope, Upper = 44:1V, Lower = 34:1V Total depth of waste = 35 ft

Cell Size = 250,000 cy Langth of waste at grade, ft. 500 Langth of cell at grade, ft. 564 Highh at top of fill, 8 = 360 Highh at bottom of cell, 80 = 350

45,666.99 112, 757.99 247,097.23 131,230.42 222,439.33 50,419.56 53,385.44 137,865.11 Side Area Side Volume Total Deartity Unit Cost Layer Cost (SF) (EY) (Cy or SF) (8) (8) 0.51 9.52 9.50 0.00 0.00 0.00 0.00 0.00 0.00 1, 149. 12 4, 121. 79 1, 533. 97 5,017.82 31, 026. 37
31, 026. 37
33, 104. 42
41, 067. 78
41, 746. 44
41, 746. 44
41, 746. 44
41, 746. 44
41, 746. 44 500.00 500.00 500.00 540.00 540.00 540.00 Thickn Side Length (ft) (ft) 花花花 隐 说 觉 觉 觉 觉 烦 惧 的 我 我 我 我 我 开 开 开 开 计 Filter Fabric
Sand
Compacted Clay
Sand
WDF
Beo-net
Filter Fabric
Soil Cap
Revegetation **Haterial** Cell Covers i ja

Layer Cost € Side Area Side Volume Total Duankity Unit Cost (SF) (CY) (CY or SF) (6) Eigh (ft) Thickn Side Length (Ft) (ft) Materia) Cell Liner: Leyer

1,009,551.22

Š

 Compacted Clay 3 58.50 506.00 26,255.21 3,199.79 30,135 8.00 241,082.03
Bottom of Clay - 67.99 524.00 31,240.93 - Linger Cost 643,942.39
Fill Cost 137,468.00
PMC Pipe 30,275.00
Total/Cell 1,821,636.61

Total 116, 584, 743.18

Length of waste at grade, ft. 940
Length of waste at grade, ft. 1004
Length of cell at grade, ft. 1004
Width at top of fill, 8 = 600
Width at bottom of cell, 8t = 835

8 98	(SE) (CY)	(CY) (CY or SF)	8	9
	74.28	1691,097	0, 18	160, 397. 48
1 72,15 940,00			12.00	396, 043. 17
3 75.28 948.00			8	829, 793. S2
1 66.65 972.00	92.36 3,012.18		12.00	429,028.93
28.77			S.	727,655.57
- 96.00	- 62.19	970,381	0.17	164,944.33
- 80,00	- 61.23	970,261	0.18	174,646.9
3 90.00	K5.19 9, R55.60	110,533	8.	442, 133.99
9 Revegetation - 105.14 1,004.00 94,63	9,855.35	1,019,342	9.8	28,541.58

Material	Picto :	hicks Side Langth (ft) (ft)	Eigh (ft)	Side Area Sid (SF)	Side Volume (CY)	Side Volume Total Deantity (CY) (CY or SF)	Unit Cost	ty Unit Cost Layer Cost (6) (6)
Filter Fabric	'	8.38	940.08	51,920.65	'	906,406	0.10	162,083.37
Pro-rest	•	8 8	8 .98	51, 920, 65	•	904,906	0.17	153, 634.29
4	•	8	8 .98	51, 220, 65	1	904, 906	6. 10.	678, 680. 69
25	-	8	8.08	51,920.65			12.80 8.31	402, 337. 15
Compacted Clay	m	S. S.	3.9	52,0%.15	6,291.73		8	621,090,65
Botton of Clay	•	62,38	8.4	61, 156, 06		•		
							iner Cost	2,216,628.35
							Fill Cost	137,466.00
							PKC Pipe	30, 275.00
							(oka)/Call	5, 739, 78, 87

Total 367,346,999.44

Cell Size . 1,558,222

Length of waste at grade, ft. 940 Length of cell at grade, ft. 1004 Midth at top of fill, 8 = 700 Width at bottom of cell, 8t = 712 Cell Cover: Layer Material Thichn Side Length Width Side Area Side Volume Total Dauntity Unit Cost Layer Cost (ft) (ft) (ft) (ft) (ft) (gr) (CY) (CY or SF) (8) (8)

ğ	430,449,40	731, 157.92	165, 729, 13	175,477.90	44, 185, 75	28, 670. 84	7 827 536 77
	12.00	S S	0.17	0	8	6.03	1
	35,671	974,877	974,877	974,677	111,046	1,023,959	٤
, ² 2				•	14, 150, 50	•	
ž Š	118, 036. 27	121,219.31	121,219.31	121,219.31	121,219.31	133, 489. 67	
	972.00	980.00	960.00	90.00	980.00	1,004.00	
	140.19	144.31	14.31	14.31	E.31	136.66	
	-	•	•	•	~	•	
	7	3	Seo-ret	Filter Fabric	Soll Cap	Reveget at son	
	•	•	•	_	-	•	

Cover Cost 3,357,628.77

je je	Material	Micton (ft)	Mictor Side Length (ft) (ft)	E E	Side Area (SF)	Side Volume (CY)	Side Area Side Volume Total Beantity Unit Cost Layer Cost (SF) (CY) (CY or SF) (6) (6)	Chit Cost	Layer Cost (6)
-	Filter Fabric	.	20 38	80.8	80,973,28	'	630,637	0.10	149,350.68
٠ ،		٠	3	90.0	80,973,28	•	630, 637	0.17	141,242.31
. ~		•	3	80.0	80, 973, 28	•	630, 637	K.	623, 127.65
,	J	-	10 g	90.08	80,973,28			12.00	369, 522, 36
•	Competent Clay	~	3	8.9	81,267.37	9, 520, 39	60° \$6	8.8	755, 269, 31
	Britten of Clay	•	2.701	864.88	20,093,62				
								Lingr Cost	2, 038, 712.51
								Fill Cost	137,468.00
								PVC Pige	30,275,00
								Total/Call	5,574,004.28
								Total	356, 741, 393.87

Cell Size = 3,000,000 cy
Length of waste at grade, ft. 1583
Length of cell at grade, ft. 1647
Width at top of fill, B = 1443
Width at bottom of cell, Bt = 1478

Unit Cost Layer Cost (6) (6)	453,406.88
Unit Cost	0, 18 12,00
Side Volume Total Guantity (CY or SF)	2,518,927
Side Volume (CY)	4,043.22
Side Area (9F)	1,583.00 109,169.53
Hidth (ft)	1,583.00
Thickn Side Length (ft) (ft)	21.55 21.55
Micha (ft)	
s Neterial	Filter Fabric Sand
Cell Covers Layer	- ~

2,360,319.34	1, 173, 718, 18	1, 286, 335, 41	450, 689, 36	477, 200, 50	1, 196, 249, 58	×. 4. 8.
8.8	12.00	S.	0.17	0°. 18	8	0. 03
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APPENDIX V

RECOMMENDATIONS FOR CONFIRMATORY WORK

V.O RECOMMENDATIONS FOR CONFIRMATORY WORK

V.1 GEOTECHNICAL AND GEOPHYSICAL STUDIES FOR SITE CHARACTERIZATION
This appendix describes geotechnical and geophysical studies that are
recommended to better define site-specific subsurface characteristics
for further development of on-site land disposal facility technology.
The general information used in the site selection process for this
task will need to be confirmed at each of the recommended sites and
site-specific values of soil properties established for use in design.

Parameters that would need to be established or confirmed include the following:

- Surface Topography. Mapping should include the candidate site and immediately surrounding area, with a contour interval of 2 ft and a scale of 1 in = 100 ft.
- 2. Groundwater Elevation. Mapping should be based on the highest elevation recorded in four seasons of data and provide a contour interval, scale, and area coverage as in No. 1 above.
- 3. Bedrock Elevation. Mapping should be in sufficient detail to reveal exposed sand channels in the bedrock surface.
- 4. Soil Properties. Soil properties to be established include:
 - o Field and Laboratory Soil Classification
 - o Standard Penetration Resistance
 - o Gradation (particle size distribution)
 - o In-Place Moisture Content
 - o Field Capacity (moisture content)
 - o Dry Density

- o Consolidation Curve
- o Shear Strength (internal friction angle)
- o Compressive Strength, Confined and Unconfined
- 5. Geotechnical Investigation. Soil sampling and testing should be performed for each soil type encountered at a site. Drill holes should be arranged based on field conditions; however, a suggested minimum spacing is one at each corner and one at the center of each planned waste cell.
- 6. Geophysical studies. Because the widely spaced drill holes described above cannot detect local or small scale features, such as sand channels or groundwater mounds located between them, the drilling and testing program should be supplemented by geophysical studies. Geophysical techniques should be used in conjunction with drilling and the two programs should complement each other (i.e., drill hole locations should be added or adjusted to investigate anomalies identified in the geophysical surveys).

Six geophysical techniques that may be applicable are briefly discussed below. They are listed in ascending order according to relative cost, except for Induced Polarization (IP), for which no cost has been determined.

1. Electromagnetic (EM) studies could be conducted to identify alluvial channels in the bedrock and paleochannels on the surface of the bedrock. EM techniques have been used on RMA as documented in a July 1986 report by Technos, Inc., prepared in support of Task 38. The Technos report showed that the best results were found where microgravity and EM techniques were used together. The variability in the data collected was concluded to be due to varying density of the bedrock. It is proposed that the results of an EM study could also be combined with well log data to

produce an accurate depth to bedrock survey. EM studies would be the least expensive of the five techniques listed here for which cost has been determined.

- 2. Microgravity studies were used in combination with EM studies on Task 38. Where the EM results were ambiguous, microgravity data were used. For example, an EM study may show a feature that could be interpreted as a paleovalley, but it would not be known if this feature was topographic in nature or whether it was a density change between clay and sand. In this situation, microgravity could be used to resolve the issue. Gravity surveys are expensive, however, because they require an accurate survey to establish ground-control points. For this reason, microgravity surveys should be used only to resolve ambiguities in EM survey data.
- 3. Ground Penetrating Radar (GPR) represents a relatively new technique for determining the depth to groundwater. GPR produces seasonally varying results depending on the amount of moisture in the alluvium. During the wet season, GPR would have less penetration, but during the dry season it would show a definite reflection at the groundwater level. Any subsurface definition below the groundwater level would be observed. GPR may have promise as a technique to define the extent of the alluvial versus the bedrock aquifer. It is not known whether GPR can penetrate down to an aquifer below 30 to 40 feet below the surface.
- 4. Seismic Refraction studies could be used to determine bedrock topography and bedrock faulting. Seismic refraction techniques produce data that are not graphic in nature and are therefore more difficult to interpret and correlate with subsurface characteristics. Refraction studies are not recommended because of this difficulty in interpreting results.

- 5. Seismic Reflection techniques, such as a weight drop, could be used to map sands on the top and near the top of the Denver formation.

 The weight drop technique shows clean results because of a high signal-to-noise ratio. The reflection technique would be the most expensive of the techniques listed and therefore would only be recommended for specific bedrock mapping objectives.
- 6. Induced Polarization (IP) techniques have been used recently by RMA staff for mapping sands in existing boreholes on RMA, with good results. The IP technique can also be used for surface measurements. It is suggested as a technique to complement rather than replace reflection studies.

To summarize the six geophysical study techniques described above: an EM technique is recommended for mapping subsurface conditions at the top of the bedrock and the overlying alluvium; GPR is recommended for depth-to-groundwater measurements when the groundwater level is above or slightly below bedrock surface; and finally, seismic reflection is recommended for mapping sands in contact with the bedrock surface or below the surface.

V.2 WASTE COMPATIBILITY STUDIES

In order to plan the placement of waste in the cells of a land disposal facility, it is necessary to establish which waste types may be disposed together and which must be segregated from each other to prevent chemical reaction. The adverse effects of such reactions can include explosion, fire, heat, leachate generation, and gas generation. Wastes that could produce such effects if brought into contact with each other would be segregated into different zones of a waste cell or into different cells.

Because the wastes at RMA include a wide variety of chemicals, the design of a compatibility testing program should be undertaken with the intent to select those wastes most likely to be reactive, excluding those that would be treated prior to disposal and those that are known

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to be nonreactive based on prior industry experience. It may be determined that treatment residues should be included in this study once the treatment processes and the types of waste to be treated are identified.

V.3 CONSTRUCTIBILITY TESTS

The facility configuration developed for this task and the operational plan presented in Appendix III are believed to reflect the state-of-the art in design and construction of such facilities. However, the materials available at RMA and the construction techniques and equipment recommended for shaping those materials into a system that will perform as required should all be tested before the start of the major construction effort that building this facility would entail.

It is usual in the preparation for construction of engineered earthwork structures to build a test fill for demonstration of the effectiveness of the materials, machinery, and techniques to be employed in the work. One element of the waste cell configuration developed for this task that should be demonstrated in a test fill is the soil barrier layer of manufactured clay, actually a bentonite - soil mixture. Both the permeability and constructibility of the soil barrier need to be demonstrated using various RMA soils and various bentonite ratios to develop an effective and economical design. The field work would take place after preparatory laboratory studies had narrowed the range of the variables and would be confirmatory in nature.

Because the waste cell is a complex system, both its construction sequence and its performance when complete are subject to improvement through testing. It is suggested that initial construction of a small capacity waste cell could be undertaken to optimize the construction method, and the completed cell subjected to testing to demonstrate its performance. The demonstration cell could be filled with inert soil materials or with simulated or actual RMA wastes, depending on the test design.

APPENDIX VI

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APPENDIX VII

LIST OF TARGET CONTAMINANTS

AT RMA

TABLE VII-1
LIST OF TARGET CONTAMINANTS AT RMA*

Analytes	Indicator ** levels (ug/g)	Waste Type
ldrin	0.3	C/H
rsenic	4.7/10.0	C/H
trazine	0.3	C/H
zodrin		C/H
enzene; Benzol	0.3	C/H
enzothiazole, BTA		C/H
icycloheptadiene; BCH	0.3/0.4	C/H
iscarboxymethyl sulfone a/		S
iscarboxymethyl sulfoxide ^{a/}		S
romide		C/H
admium	1.0/2.0	C/H
arbon tetrachloride	0.3	C/H
Chlordane	0.6/2.0	C/H
hloride		C/H
hloroacetic acid ^{a/}		S
Chlorobenzene	0.3/1.0	C/H
hloroform	0.3	C/H
-chlorovinyl arsenic acid $\frac{b}{}$		S
-chlorovinyl arsenous acid $^{\underline{\mathbf{b}}\prime}$		S
-Chlorophenyl methyl sulfide; CPMS	0.9/4.0	C/H
-Chlorophenyl methyl sulfone; CPMSO	0.3/0.6	C/H
-Chlorophenyl methyl sulfoxide; CMPSO ₂	0.3/7.0	C/H
Chromium	25/40	C/H
Copper	20/30	C/H
DE	0.3/0.6	C/H
DT	0.5/0.6	C/H
,2-Dibromo-3-chloropropane; DBCP; Nemagon	0.005/0.3014	C/H
,1-Dichloroethane	0.9/2.0	C/H
,2-Dichloroethane	0.3/0.6	C/H

TABLE VII-1 (Continued)

LIST OF TARGET CONTAMINANTS AT RMA*

Analytes	Indicator ** levels (ug/g)	Waste Type
1,1-Dichloroethylene		C/H
l,2-Dichloroethylene	0.3/2.0	C/H
Dicyclopentadiene; DCPD	0.4/1.0	C/H
Dieldrin	0.3	C/H
2-(Diisopropylamino)-n-ethyl sulfonate ^{e/}		S
2-(Diisopropylamino)-n-ethanethiol ^{e/}		S
Diisopropylmethylphosphonate; DIMP	0.3/1.0	S
Dimethyl diaulfide; DMDS	0.8/20.0	C/H
Dimethyl methyl phosphonate; DMMP		S
Dimethyl arsenic acid $^{\underline{\mathbf{b}}\prime}$		S
Dimethyl mercury b/		S
Dithiane	0.4/7.0	S
Endrin	0.3/0.5	C/H
Sthyl benzene	0.3/0.4	C/H
Sthyl methyl phosphonate (EMP) ^{e/}		S
Ethyl methyl phosphonic acid (EMPA)		S
Fluoride ^d		S
Pluoroacetic acid ^{d/}		S
SB; Sarin		S
Rexachlorocyclopentadiene; HCCPD	0.3/0.6	C/H
Isodrin	0.3	C/H
Isopropyl methyl phosphonic acid $^{{f d}/}$		S
sopropyl methyl phosphonate (IMP) $^{{f d}/}$		S
ead	25/40	C/H
.ewisite		S
ewisite oxide		S
lalathion	0.3/0.7	C/H
lercury	0.05/0.1	C/H
Methylene chloride	0.7/2.0	C/H
fethyl arsenic acid ^{b/}		S
3 0023w 09/15/88		

TABLE VII-1 (Continued)

LIST OF TARGET CONTAMINANTS AT RMA*

Analytes	Indicator ** levels (ug/g)	Waste Type
Methyl isobutyl ketone	0.3/0.7	C/H
Methyl mercury salts ^b /		S
Methylphosphonic acid		S
Mustard		S
N-Nitrosodimethylamine ^{C/}		C/H
Parathion	0.4/0.9	C/H
Supona	0.3/0.6	C/H
Tetrachloroethylene	0.3	C/H
Thiodiglycol ^{<u>a</u>/}		S
2,2-thiodiglycolic acid ^{a/}		S
Thioxane; 1,4-0xathiane	0.3/6.0	S
Toluene	0.3	C/H
1,1,1-Trichloroethane	0.3/0.4	C/H
1,1,2-Trichloroethane	0.3/0.4	C/H
Trichloroethylene; TCE	0.5	C/H
Trimethyl phosphate		C/H
Vapona	0.3/3.0	C/H
o,m,p-Xylene	0.3/5.0	C/H
Zinc	60/80	C/H

Legend: C/H = Chemical/Hazardous; UXO = Unexploded Ordnance; S = Surety

<u>a</u>/ Degradation product of mustard.<u>b</u>/ Degradation product of lewisite.

c/ Degradation product of hydrazine

d/ Degradation product of GB.

e/ Degradation product of VX.

This is a preliminary list of target contaminants for RMA Task 35 as of December, 1986.

^{**} Indicator levels are given only where USATHAMA certified methods and reporting limits have been established.

APPENDIX VIII

COMMENTS AND RESPONSES

Shell Oil Company



e/o Holme Roberts & Owen Bulte 1800 1760 Broadway Denver, CO 80280

October 20, 1987

FEDERAL EXPRESS

Mr. Donald L. Campbell
Department of the Army
Office of the Program Manager
Rocky Mountain Arsenal
Contamination Cleanup
ATTN: AMXRM-EE
Bldg. 4460

Aberdeen Proving Ground, MD 21010-5401

Re: United States v. Shell Oil

Dear Don:

Enclosed herewith are Shell Oil's comments on the Draft Final Report on Task No. 27 - Hazardous Waste Land Disposal Facility Assessment.

Sincerely,

C. K. Hahn

Manager

Denver Site Project

CKH/mp/14222

Enclosure

cc: (w/enclosure)
USATHAMA
Office of the Program Manager
Rocky Mountain Arsenal Contamination Cleanup
ATTN: AMXRM-EE: Mr. Charles Scharman
Bldg. E4460, Trailer
Aberdeen Proving Ground, MD 21010-5401

Mr. Thomas Bick Environmental Enforcement Section Land & Natural Resources Division U.S. Department of Justice P.O. Box 23896 Benjamin Franklin Station Washington, DC 20026

Mr. Scott Isaacson Headquarters - Department of the Army ATTN: DAJA-LTS Washington, DC 20310-2210

Ms. Patricia Bohm Office of Attorney General CERCLA Litigation Section 1560 Broadway, Suite 250 Denver, CO 80202

Mr. Dave Shelton Colorado Department of Health 4210 East 11th Avenue Denver, CO 80220

Mr. Jeff Edson Colorado Department of Health 4210 East 11th Avenue Denver, CO 80220

Mr. Robert L. Duprey Director, Air & Waste Management Division U.S. Environmental Protection Agency, Region VIII One Denver Place 999 18th Street, Suite 1300 Denver, CO 80202-2413

Mr. Connally Mears U.S. Environmental Protection Agency, Region VIII One Denver Place 999 18th Street, Suite 1300 Denver, CO 80202-2413

RESPONSES TO COMMENTS OF SHELL OIL COMPANY ON TASK 27, HAZARDOUS WASTE LAND DISPOSAL PACILITY ASSESSMENT

Comment 1:

Page 1-1, third paragraph, first bullet: A statement should be included identifying the assumption that was made concerning the volume of waste that might be a candidate for disposal in the facility. It is inappropriate to lead the reader to assume that all potentially identified contaminated soils will be disposed of in the subject landfill. The volume used by the Army is an extremely conservative estimate of a potential upper bound on the size of the landfill.

Response:

The comment appears to address the first sentence of Section 1-1 and the first and second bullets of Section 1.3, rather than the cited first bullet of Section 1.2.

These sections have been revised to further identify the assumptions on which the volume estimate is based. There is nothing inappropriate in these assumptions; the volume estimate is meant to provide an upper bound for the site cleanup need for landfill capacity.

For this purpose, the estimate must be conservative. No one can say whether it is "extremely conservative," as the commentor claims, until the outcome of the "How Clean is Clean?" effort and decisions regarding land use and groundwater cleanup. Therefore, the assumption used in this assessment that detection limits for organics define action levels is an appropriately conservative approach.

Comment 2:

Page 1-2, top of page, last bullet: Preparing a report describing the waste sources appears to be an unnecessary effort in the context of this task. It is premature to assemble this information for inclusion in the report because screening of treatment technologies has not taken place. It is, therefore, premature to presume all wastes will be disposed in the landfill.

Response:

We disagree from a waste management perspective and from a land disposal facility siting perspective. Land disposal facility feasibility studies can be very site-specific and waste-handling dependent. It is not inappropriate to make a best engineering judgment estimate of the maximum waste volumes (i.e., primarily contaminated soil) and waste sources with their location and potential soil type, in order to establish the upper-bound facility capacity.

Comment 3: Page 1-3, top of page, second line: Insert "which may be" between "processes" and "required". A treatment has not been

selected, therefore, it is premature as stated.

Responses: We agree with the comment and have made the change.

<u>Comment 4:</u> <u>Page 1-3. first bullet:</u> Liquid wastes could be disposed of at such a facility if a solidification-type pretreatment were

utilized.

Response: The statement on page 1-4 simply reflects the liquid waste

disposal prohibition. We agree that a solidified waste is not a

liquid waste. No change to the text is required.

Comment 5: Page 1-4, fourth paragraph: Has a cost estimate been made which

demonstrates that it is more effective to create a manufactured

clay for the waste cell than to import all new clay?

Response: No. The manufactured clay will probably be more expensive than

local imported clay. The choice for this assessment was made on the basis of assured quality of the product, given that local

natural clays on or off the RMA do not appear to be of

sufficiently low permeability. Since the manufactured clay is more costly, the conservation of the estimate of this item is

ensured.

Comment 6: Page 3-4, first line: The 50-year average annual precipitation

at Stapleton is 15.31 inches, not the reported 14 inches

(National Climatic Data Center, 1985).

Response: The reported 14 inches average annual precipitation was obtained

from a climatic atlas isohyetal map and from the Soil Survey of

Adams County. The value in the text has been changed to 15

inches. The change does not affect the discussion.

Comment 7: Page 3-4, second paragraph: It is the opinion of Shell and

Morrison-Knudsen Engineers (MKE) that significant deep percolation does occur over vegetated soils on the RMA. As an

example, calculations have indicated an average annual deep

percolation of 0.78 inches over a 10-year period for a

vegetated, 36-inch layer of Blakeland Loamy Sand. Less sandy soils allowed less deep percolation. It is an oversimplification

to conclude that "free soil moisture does not normally penetrate

much below 12 inches" in medium to moderately fine textured

soils due to the presence of calcium horizons.

Response: Significance depends on the subject under consideration. The term "significant" can be interpreted in relation to groundwater

term "significant" can be interpreted in relation to groundwater hydrology, in relation to waste cell performance, or in relation to contaminant migration from specific contaminated sites on RMA. "Significant" deep percolation, as it relates to groundwater hydrology, implies an amount sufficient to recharge the aquifer or to supply wells. The amount of recharge calculated by the commentor would support only one 750 gpm well for the entire area of RMA, which hardly seems "significant" compared to the water requirements of irrigated crops if they covered the same area; it would not even supply the actual water consumption of Commerce City, immediately downslope on the aquifer.

"Significant" deep percolation, as it relates to waste cell performance, would be a much greater amount than the .78 inch the commentor has calculated; in Figure 5-10, HELP model results for percolation through a 24-inch vegetated soil layer are shown as 1/2 inch per year. That amount is not "significant" in the sense of being an obstacle to a demonstration of successful waste cell performance, although it is an overestimate of the expected percolation, based on a conservative application of the model.

There is no Blakeland loamy sand at the locations studied for the disposal facility, which are Ascalon, Platner and Truckton soils. These are less sandy and more fine textured than Blakeland and include calcium horizons, which according to the commentor means they allow "less deep penetration, much below 12 inches in medium to fine textured soils due to the presence of calcium horizons." This is a fair statement of the position taken in the discussions presented in this part of the assessment and contradicts the commentor's opinion that "significant deep percolation does occur." However, the detailed public health implications basis for this assessment is the HELP model that, when conservatively applied, predicts a small amount of deep percolation as discussed above.

That some deep percolation does occur is evidenced by the vertical migration of contaminant plumes in the unsaturated soil zone from some contaminated sites on RMA. The context of the sources' observations about soil moisture and deep percolation did not encompass contaminant plumes. If there were no deep percolation whatever, the plumes would not migrate toward the water table and the number of RMA waste sites requiring remediation might be reduced. In this sense, any deep percolation at all is "significant;" however, that is not the context of the regional discussion on Page 3-4, which is directed toward an assessment of the suitability of the area for a waste disposal facility.

No change to the text is required.

Comment 8: Page 3-7, third paragraph (also page 3-10, second paragraph):
The statement is made that faults were not mapped as site
selection criteria because of the lack of accurate maps. We
believe that the faulting issue at RMA has not been properly
addressed. Several maps have been produced by Army contractors
locating faults in the Basin A-Neck area based on lithologic
logs. We believe that the lithologic data does not necessarily

indicate such faulting.

Response: The faults inferred by various investigators from well log data may or may not exist, and the investigations required to establish this have not been performed. However, the inferred faults lack surface expression and have no identified association with the recent seismicity of the area, so that there is no presently known evidence of near-surface holocene fault movement on RMA. There is a consensus that no faulting has occurred in Holocene time.

Therefore, maps of inferred faults in the Denver Formation do not affect selection of facility locations for the purposes of thim Assessment, which is based strictly on available information.

A more detailed examination of any postulated faulting affecting particular candidate sites would be appropriate to support further development of the waste disposal alternative should a decision to proceed beyond this assessment result from the CERCLA process, in the event that other investigations had not resolved the matter by that time.

No change to the text is required.

Comment 9: Page 3-7, last complete sentence: The RMA injection well was 12,045 feet in depth.

Response: This information has been incorporated in the text.

Comment 10: Page 3-10, first paragraph: There are several qualifying words used in the sentence. The conclusion, while firm, is based on these qualified statements. For example, "the geophysical surveys conducted during the 1960s suggest that it does not expand into the sedimentary rocks overlying the linear zone of earthquakes" doesn't make a solid case for the final statement that the fault is more than 1,000 feet from the surface.

Response: Geologists, as scientific professionals, nearly always qualify their opinions for the good reason that further investigation may prove them wrong. Decisions based on their qualified opinions, however, have of necessity a more absolute "go" or "no go" quality. In this case, the assessment finding is that no siting restriction on account of the Derby Fault has been

identified by the geologists who have studied it. This firm statement is fully and sufficiently supported by the qualified statements made by the sources.

No change to the text is required.

<u>Comment 11:</u> <u>Page 3-10, second and third paragraphs</u>: The discussion on faulting in the Basin A area is not supported by the interpretation of the available data.

Response: It is assumed that "the discussion" referred to is that of May et al. (1983), and that "the interpretation" referred to is that of others who are not identified in the comment.

Further work has been performed by other parties, including Ebasco, in the Basin A area since that described by May et al. (1983). A paper co-authored by Ebasco's L. Irons (Crowder et al., 1987) provides a description of some of that work. The more recent work does not alter the significance of the overlying Pleistocene lacustrine and alluvial deposits in indicating an early Pleistocene (at the latest) date for Basin A inferred faults. Therefore, these features (whatever their interpretation) do not represent a siting restriction, as stated in the fourth paragraph of page 3-10.

No change to the text is required.

Comment 12: Page 3-11, first complete sentence: There is no geologic evidence of faulting in the Basin F area. It is speculative to postulate their existence on the basis of a creative interpretation of limited data in the Basin A area.

Response: We agree. The sentence has been deleted from the text.

Comment 13: Page 3-12, second paragraph: Refer to comment number 38 for a discussion on travel time calculations. Relying on the unsaturated zone to secure 1,000 years of isolation is not a conservative design approach.

Response: An effort has been made in this assessment to emphasize natural as opposed to man-made barriers to contaminant migration in accordance with EPA guidance.

Recalculation of the travel time using the EPA guidance manual method as recommended by commentor at 38(b) gives a minimum travel time in the unsaturated zone of 1,514 years, compared with 726 years calculated time to reach field capacity, which indicates the conservatism of travel time calculations made by that method. A complete comparison is provided in revised Table 5-6.

Comment 14: Page 3-15, first paragraph, last sentence: If the decision were made to decommission the North Plants, would it then be possible to expand the area under consideration for a landfill facility?

Response: The potential difficulty and complexity of North Plants decontamination and site cleanup was the basis for an exclusion criterion to our landfill siting work. The criterion was to exclude such contaminated sites as North Plants, South Plants, Basin F, and Basin A (See Figure 3-4).

Comment 15: Page 3-15, last paragraph: The volume estimate is not based upon the best available information, but rather on an old estimate with the detection limits employed at that time. This is only a convenient figure considering that no action levels have been established nor have technologies been selected for treatment options.

Response: The estimate reflects the best engineering judgment for the maximum required facility capacity made at the time the assessment was prepared, as demonstrated in Appendix I, Table A-2. The text has been changed to reflect this.

Comment 16: Page 3-17. Table 3-2, last item: Calculating a volume-distance weighted centroid using the current volume estimates will necessarily result in misleading conclusions. The calculation will change substantially once action levels are set and alternative treatment technologies are brought to bear. Such a calculation is meaningless this early in the RI/FS process.

Response: The volume-distance weighted waste centroid is a common feasibility study tool for estimating potential differences in transport costs between waste management facilities. Distance from the waste centroid is a reasonable criterion for siting landfill or other waste management facilities. Also, whatever action levels are set, the location of the contaminated sites will not change and the centroid will be close to the position calculated in this Assessment.

Comment 17: Figure 3-5: Our interpretation of the available data indicates that saturated alluvium exists in a bedrock channel exiting the Basin A area in a northwesterly direction. No such continuous "A-Neck" is indicated on the figure.

Response: The "A-Neck" is a small feature within a larger surrounding region of saturated alluvium displayed on Figure 3-5. For this assessment, no purpose would be served in specifically identifying such a local feature, continuous or not. The second paragraph of the unsaturated alluvium criterion discussion on page 3-14 and the sand channels discussion on page 3-21 place these subjects in context for this assessment.

No change to the text is required.

- Comment 18: Page 3-50, entire page: Significant recharge in the form of deep percolation from vegetated areas can occur over the RMA.

 The discussion on this page oversimplifies this issue. Specific comments are as follows:
 - To discount the HELP model results on the basis of the Resource Consultants Inc. (RCI) 1982 report is improper. The RCI use of the Blaney-Criddle method was a monthly water balance approach that could not take into account the day-to-day or moment-by-moment fluctuations in rainfall, solar radiation, etc. Using such a crude time-step masks the deep percolation predicted by the more refined HELP model daily calculation approach. The HELP model results have been confirmed by an in-house modeling effort which uses time steps as small as 5-minutes during precipitation events.
 - o Another problem with the RCI approach is that the winter season was not considered. Only the months from April to October were analyzed. This does not account for the potential percolation during the wet spring season when the ground can be relatively warm with multiple wet snowfalls.
 - o Fourth paragraph: It is obvious that the averaging that occurs using a monthly water balance approach will not pick up the effects of individual major storms. Therefore, it should not be surprising that monthly consumptive water use calculations would not demonstrate the deep percolation one would expect to see associated with storms.

Response:

The statement that "significant recharge in the form of deep percolation from vegetated areas can occur" contradicts the conclusions of previous workers at RMA and the HELP model results obtained in this assessment. The HELP model results show a small amount of deep percolation occurs; the only sense in which it is "significant" is that it can move contaminant plumes downward toward the water table from contaminated sites on RMA. This is not "recharge" in the customary sense.

The discussion on page 3-50 does not "oversimplify this issue," rather, it refutes the commentor's opening statement by reference to the conclusions of previous workers and presentation of the results of the HELP model calculations performed in this assessment. The first paragraph of page 3-50 refers to "slow rate of migration of leachate" from a properly designed disposal facility, not from contaminated soils sites; the text has been expanded to clarify the intention.

The first specific comment states that it is improper to discount the HELP model results on the basis of the Blaney-Criddle method owing to the monthly time step used in the latter versus the daily time step in the HELP model. The intent

of the discussion on page 3-50 was to establish the conservatism of the HELP model, which, far from being "discounted," was used as the basis for development of waste cell configuration in Chapter 5.

The time step objection would become meaningful only under wet conditions not usually found at RMA with its large available water capacity of the soil; as long as there is available water capacity, the time step is of interest only in predicting runoff versus soil infiltration, for which case the Blaney-Criddle method errs on the conservative side by ignoring runoff.

In the same RCI work, the average runoff from RMA, adjusted from RCI Table 4 to account for vegetated areas only, is .5 in/year; the HELP model gives .1 in/year, or about one-fifth the run-off calculated by RCI, another indication of the conservatism of the HELP model (Report Section 5.4.3, item 1 on page 5-35).

The second specific comment states that the Blaney-Criddle method does not account for the potential percolation during the wet spring season prior to April. Again, this comment may have some application to climates which experience wet spring seasons, however, at RMA there is virtually no effective (i.e., greater than 0.1 inch in a single storm) precipitation prior to April. That portion of rainfall and snowmelt that does not escape as evaporation and runoff enters the soil and recharges the top 12 inches depleted of moisture in the previous year's growing season, as described in the Soil Survey of Adams County. No problem with the approach exists on account of the winter or "wet spring" seasons, which are appreciated in the sources and in the discussion derived from them.

The third specific comment states that "the averaging that occurs using a monthly water balance approach will not pick up the effects of individual major storms." One effect of individual major storms is to create runoff, since the effective rate of percolation of surface water into the soil is less than the precipitation rate at the peak intensity of such storms. Far from failing to "demonstrate the deep percolation one would expect," the error is on the conservative side so long as the available water capacity of the soil has not been used up, since the runoff lost is not acknowledged by the method.

No change to the text is required.

Comment 19: Page 3-51, last sentence: This sentence overstates the case.

Over an extended time, percolation will penetrate the cap and reach the waste.

Response: The sentence overstates the case in that no time limit was given. The sentence has been revised.

Comment 20: Page 4-11. last time in list: Using the HELP model's default climatological data (1974-1978) is inappropriate. These years were below-average in precipitation (12.99 inches vs. 15.31 inches for the 50 years through 1985). A more appropriate approach would be to employ the HELP model's ability to accept 20 years of user-defined climatological data. The wettest consecutive 20 years from 1949 to 1983 were 1955 through 1974, with an annual average precipitation of 15.98 inches and a peak daily precipitation of 3.27 inches. (The peak daily precipitation of the HELP default data is only 1.79 inches.) Using such relatively lower precipitation values will result in overpredicting landfill performance.

Response:

For the purpose of this assessment the default data are considered sufficient to identify the best waste cell cover and liner configuration. The example demonstration of the protective life of the facility has been revised using 20 years of daily precipitation data from 1963 to 1982, for which period the average annual rainfall was a more representative 15.13 inches (16-1/2 percent more than the 12.99 inches in the 1974-1978 HELP Model default data set). The calculated percolation rate from the base of the waste cell cover increased by only 4 percent, which indicates that there is a relatively small sensitivity of waste cell performance to minor variations in precipitation. The revision does not alter the conclusions of the assessment. More extensive climatological data would be used for further development of the concept.

The text has been changed (Section 5.4.2, page 5-28 and Section 5.4.3, page 5-32) to reflect the results of the expanded analysis, which has also been revised to incorporate more complete soil and vegetation information than were used in the draft.

Comment 21: Page 5-3, item (a): What are considered "acceptable levels" for soil loss in this conceptual design? Sufficient data stating what USLE parameters were chosen should be provided to reviewers to allow them to conduct a meaningful review.

Response: The acceptable levels utilized for this assessment are in substantive conformance with RCRA, i.e., erosion of less than 2 ton/acre.

Comment 22: Page 5-3, third paragraph: We disagree with the statements regarding precipitation at RMA. The following table of data is from 50 years of record through 1985 (Source: NCDC, 1985. All values in inches).

Year J F M A M J J A S O M D
15.31 0.51 0.69 1.21 1.81 2.47 1.58 1.93 1.53 1.23 0.98 0.82 0.55

Also, using terms such as "leachate runoff" confuses the water balance issue.

Response: The text has been changed to reflect 15 rather than 14 inches of rainfall a year. The changes do not alter the conclusions of the discussion. It is necessary to use the phrase "leachate rumoff" in this context; the "soil water balance" has nothing to do with the subject under discussion on page 5-3, which is concerned only with surface water management.

Comment 23: Page 5-10. Pigure 5-5: What are the assumptions for this figure (e.g., waste volume, height, etc.)? What do the different curves represent? The text is not clear.

"assumptions."

The text and figure have been changed to identify that the

The text and figure have been changed to identify that the curves are for different cell side lengths, which was inadvertently omitted.

The commentor appears to mean "parameters" rather than

Comment 24: Page 5-11, fourth paragraph, first sentence: A review of Figure 5-6 indicates that the A Concept costs are closer to the B Concept than to the C Concept.

Response: This comment appears to refer to the last sentence rather than the first. The text has been revised.

Comment 25: Page 5-11, fifth paragraph, last sentence: Figure 5-6 indicates that the B and A concepts are closer in cost than are the B and C concepts.

Response: We agree. The text has been revised.

Comment 26: Page 5-16 and following, paragraph 5.3.3: The text does not recognize that certain types of wastes can impact a bentonite amended soil liner. Other soil liner systems are rejected due to a lack of information, yet a bentonite amended soil liner is chosen without a similar discussion.

Response: It is fully realized that a bentonite amended soil liner may be susceptible to attack. It is beyond the scope of this assessment to evaluate liner/leachate compatibility for actual disposed concentrations of all the possible specific wastes at RMA, which, by regulatory requirement, is done on a case-by-case basis during facility operation. The bentonite liner was selected based on engineering judgment considering the uncertain availability of suitable clay at or near the RMA and the general character of the material likely to be disposed. Since bentonite amended soil is more expensive, the choice is the conservative one.

Response:

Comment 27: Page 5-17, second paragraph, second sentence: The referenced report (Martin, 1986) appears to be an internal Ebasco document. Please produce this report to the MOA parties.

Respons: This report has been delivered to the MOA parties.

Gomment 28: Section 5.4.1 (pages 5-20 through 5-28): This section discusses the selection and configuration of various landfill cover components by using the HELP computer program water balance simulation. It is not possible to review this section in detail without the actual computer output. The HELP model requires much climatological, soil, vegetative and dimensional data, any of which have a significant impact on calculated percolation rates. Input data must be reviewed for reasonableness and consistency. Also, a discussion of the assumptions underlying the HELP code is in order before conclusions are arrived at prematurely.

Response: Although actual data entries are not listed in the HELP model format, the values of the input parameters are already discussed in the text in more than usual detail for a report of this type. It would be inappropriate to incorporate voluminous technical calculations in the assessment.

HELP files have been transmitted to the commentor as a courtesy.

Comment 29: Page 5-23. Table 5-2: The cover system shown in Table 5-2 should be analyzed using the 20 years of Denver precipitation data from 1955 through 1974. The 5 years of default precipitation data used in the HELP code were unusually dry years. (See comment 11 above.)

Response: Commentor apparently means to refer to his Comment 20, not Comment 11, which deals with faulting in Basin A rather than rainfall.

The five years of default data supplied with the HELP model were used, together with other available information, to guide selection of the best waste cell configuration in a feasibility level technology assessment, for which use the default data are adequate. A revised public health implications sensitivity analysis has been performed, as described in the response to Comment 20, which confirms that use of 20 years of representative rainfall data does not alter the conclusions of this assessment.

In any further development of this technology for application at RMA, a more precise deep percolation value would be obtained by using more complete climatological data, together with more precise and site-specific topographical, groundwater, soils, and vegetation information than were available for this assessment.

Comment 30: Page 5-23. Table 5-2:

- (a) What values for the following parameters were used to generate this table:
 - Evaporation depths(s) (a critical parameter)
 - Vegetative cover type/condition
 - Porosity, field capacity, wilting point and effective hydraulic conductivity of the various materials
 - Runoff curve number(s)
- (b) Was any attempt made to match soil parameters with actual RMA soils?
- (c) Table 5-2 is used as the basis to conclude that negligible benefit is derived from increasing the vegetative soil layer thickness. This conclusion is premature and depends on the soil wilting point, porosity and the assumed evaporative depth(s).

Response:

Values of the parameters used in the various computer runs are too voluminous to repeat here. They are available in the HELP model files, which have been transmitted to the commentor. The values are those given or recommended by the sources cited in the text.

As stated on Page 5-35, first paragraph, which the commentor has recognized at the end of Comment 37, soil data (unit weight, moisture content, and porosity) were obtained from soil investigation reports available in the Shell database. The values selected for use in the assessment represent a composite of RMA soil types rather than a particular soil at a particular spot. They are also similar to the values of those parameters used in other geological evaluations at RMA.

We disagree that the conclusion is premature, although it certainly does depend on the named parameters (called "assumptions"). The assumption used in the assessment was that the vegetation that would establish and maintain itself with a minimum of human intervention was native prairie grass; the values of the parameters were determined from the Soil Survey of Adams County and the HELP model user's guide for this vegetation. The conclusion is valid for the range of depths and the vegetation type used, even though the evaporative zone depth has been increased in accordance with further guidance from the author of the HELP model for the facility protective life estimate.

Comment 31: Page 5-24, top paragraph: The argument is presented that a three foot clay barrier is preferred over a two foot barrier. It is also stated that increasing the thickness from two to three feet reduces percolation by 0.002 inches per year. (This is equivalent to a 0.4 percent reduction.) On page 5-22, third paragraph, a 3 percent change in percolation rates is considered "a small gain in efficiency" that cannot be used to justify the increased cost of an additional drainage layer. This inconsistent reasoning should not be used to support a premature commitment to three foot thick clay barriers.

Response: The EPA Guidance Document for a double-lined facility recommends a three-foot clay barrier from a construction quality assurance standpoint. This assessment follows the Guidance Document's recommendation, as clearly stated on page 5-24.

Comment 32: Page 5-24, third paragraph, last sentence: A hydraulic conductivity of 1,500 in/hr is two orders of magnitude higher than a GS soil as listed in the HELP manual in Table 2 (p. 15). Also, EPA guidance specifies 10⁻² cm/sec (14 inc/hr) as a minimum. 1,500 in/hr seems excessive and will exaggerate the calculated cap performance. Therefore, Case 1 on Table 5-3 is more reasonable.

Response: The drainage layer is not a "GS Soil" and, therefore, the default soil properties for that soil provided in the HELP model in Table 2 were not used. The goal of the modeling was to design the most efficient liner and cover system. A clean gravel layer has a hydraulic conductivity between 5,000 and 50,000 in/hr (U.S. Dept. of the Interior Groundwater Manual, page 28). It is therefore reasonable to assume that a drain layer can be designed to have a hydraulic conductivity of 1,500 in/hr.

Comment 33: Page 5-27, fourth paragraph, first sentence: Depending on soil type and rooting depth, the thickness of the uppermost soil layer in the cover profile can have a significant effect on deep percolation.

Response: This appears to be a derivative of Comment 30(c). The statement is true, but inapplicable. Since soil type and rooting depth are defined, as described in the response to Comment 30(c), the thickness of the uppermost soil layer has no significant effect on deep percolation.

Comment 34: Page 5-28, last sentence: The HELP model is sensitive to runoff curve number selection. An artificially low value should be used to eliminate runoff and consequently enhance infiltration, thereby resulting in a conservative estimate of landfill cover performance.

Response:

The HELP model is relatively insensitive to modest changes in curve number. This was verified by a HELP run varying the curve number from the default of 84.4 to a value of 71. We disagree that runoff should be eliminated through use of an artificially low value on the grounds that such an approach is unnecessary where the landform is controlled. It may have application in the case of municipal sanitary landfills, where control of landforms to maintain drainage is made difficult by large differential settlements in the organic waste; however, the RMA waste is predominantly in the form of contaminated soil and the waste zone would be constructed as an engineered fill, minimizing subsequent settlement and allowing a high degree of confidence that drainage slopes would be permanent.

Comment 35: Page 5-31. Table 5-5:

- (a) The interpretation of this table is difficult without additional details on the input data used to generate the results. It is assumed that the results are based on the 5 years of climatological data from 1974 to 1978. The table indicates that the water percolating through the cap displaces an equivalent volume out of the waste zone and into lateral drainage and vertical percolation out of the landfill bottom. It must be recognized that the HELP model is conservative in that it sets the initial moisture content of the waste zone at field capacity. This results in the release of leachate out of the waste zone as soon as the first drop enters the waste from the cover system. In reality, proper construction methods combined with the semi-arid Denver climate will result in the waste zone having a significant storage capacity prior to reaching field capacity.
- (b) As stated in previous comments, for conservatism, the HELP model should be run with 20 years of "wetter" climatological data and an artificially low curve number to enhance infiltration.

Response:

The table input data corresponds to the waste cell cross-section shown in Figures 5-8 and 5-9 and the default climatological data of the HELP model.

We understood the nature of the HELP model described by the commentor and, therefore, constructed the time history of waste cell performance shown in Figure 5-11 to reflect a realistic appreciation of the waste zone storage capacity.

As stated in previous responses, a facility protective life study using 20 years of representative rainfall data has been performed. A more complete climatological record would be used in any further development of this technology for application at RMA; however, we do not endorse manipulating either rainfall data or curve numbers to achieve unrealistically conservative results. The approach taken is sufficiently conservative.

Comment 36: Page 5-32, second paragraph, fourth sentence: The design life of a synthetic liner is typically assumed to be through the 30 year post-closure period.

Response: HDPE is an extremely inert material. It has a design life in a sheltered environment theoretically approaching infinity.

Nevertheless, the typical design assumption that it starts to fail as soon as active monitoring and maintenance ceases has merit. For ease of calculation, we have not attempted to model progressive liner deterioration using repeated HELP model runs, but have simplified the liner performance history into two stages: an initial leak-tight period followed by a complete 100 percent failure.

In the event this technology were to be chosen for further development, a more sophisticated treatment of the performance history of the HDPE liners would doubtless be undertaken, since the HELP model offers the tools to support it.

Comment 37: Page 5-33. Figure 5-10: This figure reflects the unusually dry 5-years of HELP default precipitation data (12.99 inches). The 0.13 inches of runoff should be eliminated by setting the curve number at 50.

Response: Figure 5-10 has been revised based on more representative rainfall data. We do not agree that runoff should be eliminated; see our response to Comment 34.

<u>Comment 38</u>: <u>Page 5-34</u>, <u>Table 5-6</u>:

(a) Again, it is difficult to interpret this table without the details on the input data used by the HELP model. The last sentence on page 5-32 that continues on page 5-35 states that the moisture content and porosity of the foundation soils was taken from unspecified Shell documents. The reference (Shell, undated) is not sufficient to locate this information. The characteristics of the foundation soils are obviously critical inputs to the total travel time calculation since 827 years out of 945 (88 percent) are expended traveling through the unsaturated zone. Date taken from Shell's South Plants foundation reports (page 5-35) may not represent Shell's typical RMA conditions.

- (b) What analytical method(s) were used to calculate the travel time on this table? What assumptions are inherent with the method(s)? It appears that the table reflects the following assumptions:
- o Clay barriers are at 40 percent moisture. This appears high.
- o The waste layer is at 23.8 percent moisture. This appears high.
- "Travel time" is equivalent to the time that the calculated flux rate takes to fill the storage capacity volume between field capacity and in situ moisture content. This is an oversimplification of a complex phenomenon, and is more appropriately called a "fill-up" time instead of a "travel time". The calculations should be executed using unsaturated flow equations. Methods for such an analysis are provided in the July, 1986 EPA Guidance Manual on the determination of time of travel and "vulnerable hydrogeology".
- (c) Even with the above assumptions, some of the values in Table 5-6 appear to be in error. The 0.0238 value under the "In Situ" column should be 0.238. The 0.98 value under the "Storage Capacity" column should be 0.018. The 0.108 value under the "Soil Storage" column should be 1.8.

Response:

The table in question (5-6) is partly a table of HELP model input and output data as well as a summary of travel time calculations.

There is a detailed reference to 13 specific sources in the Shell database for RMA given by microfilm number in the citation (Shell, undated). These data, while they mostly represent the South Plants area, are the only documents carrying the relevant information revealed in a key-word search of the Army's Shell RMA database; their values of soil parameters lie in the expected range considering the locations, depths, and soil classifications, and compatible regional information. It is better to mention these data than to omit them, as they are the geographically nearest reports on the parameters of interest in facility performance evaluation. The documents have been provided to the commentor as a courtesy.

Table 5-6 has been revised to reflect further studies, so the particular numbers cited in the comment are no longer found.

The method involves calculating the time required ("fill-up time," as the commentor states) for the layer under consideration to reach field capacity at the rate of percolation from the layer above illustrated in Figure 5-10. The table has been revised to also incorporate results obtained using the methodology recommended by the commentor.

We agree that the initial moisture contents were deliberately set high to achieve a reasonable level of conservatism. The RMA soils investigations found in the Shell database are predominantly located at South Plants where the groundwater table is very high. The samples chosen were those above the groundwater table, whenever groundwater levels were identified; however, they were all very close to groundwater and accordingly are believed to be wetter than would be typical for soils averaging much further from the water table in Sections 25 or 29 where the facility would be located.

The corrections to Table 5-6 have been made, together with adjustments to incorporate more of the Shell database, soils data, and the additional analyses described in the Response to Comment 37b.

Comment 39: Page 5-35, item 2: There is insufficient data in the industry to conclude that synthetic liners begin to degrade slowly after 100 years.

Response: The statement on the liner life has been revised.

Comment 40: Pages 7-2, 7-3: Figures 7-1, 7-2: These figures are somewhat misleading in that one of the four curves is based on a 60 foot waste height. Another set of curves based on varying waste heights would be useful.

Response: The requested curves are provided in Figure 5-5, discussed on pages 5-8 and 6-5.

No change to the text is required.

Comment 41: Pages 7-6 to 7-7. Section 7.4: This discussion on the economic analysis is surprisingly brief in light of the multitude of options considered (e.g., cell size, waste height, build out period). The following specific comments apply to this section:

Page 7-6. second paragraph: This paragraph is confusing when compared to the curves in Figures 7-1 and 7-2. The 3,000,000 CY cell layout is more expensive than the 1,500,000 CY layout, but this no doubt due to the different waste heights and is therefore a misleading comparison. The last sentence states that there is only a "small cost differential" between the 1,000,000 CY cell (at 35 feet) and the 1,500,000 CY cell (at 60 feet). The curves do not support this statement.

Response: The intent of this section is to summarize the general effects of varying key parameters rather than to recommend or justify one particular choice of size, height, or buildout period. Should this technology be selected for further development under

the CERCLA process, choices would be made during the design effort based on better knowledge of volumes of waste to be disposed, buildout period, exact site size and location, and a more detailed economic analysis.

The cost estimate is printed in full in Volume II, Appendix IV, for the use of those who may wish to perform a more detailed economic analysis.

With respect to the specific comments on the curves in Figures 7-1 and 7-2, possibly the commentor is judging the relative costs based on the appearance of the figures without taking into account that the ordinate axes are not zero; for this reason, the "spread" between the curves is much less than appears at a casual glance.

No change to the text is required.

Comment 42: Page I-15, first paragraph: Contaminant toxicities and the endangerment assessment will obviously result in a different volume of "heavily contaminated soil" requiring treatment than

the approach taken here.

Response: The differences in "heavily contaminated soil" will be determined based on contaminant concentration in the waste, toxicities, risk assessment, and exposure pathway modeling (i.e. endangerment assessment). The feasibility study waste volume estimates reflect the best engineering judgment made at the time of the estimate on the maximum potential site cleanup waste volume. The modular design of the land disposal facility would allow for construction of a facility of any size up to the

maximum size evaluated, i.e. 16,000,000 cubic yards.

Comment 43: Page V-2, item 4: There is a reference to the relative value of seismic refraction versus other methods used in Task 38. Shell would appreciate being informed of the method(s) employed and the results obtained as this is not reported in Task 38. Preliminary results of a Shell investigation indicated that shallow seismic refraction techniques would be successful in

spotting offsets as small as 10-15 feet.

Response: The commentor is correct. The information is contained in a report of Technos, Inc. (Technos, 1986), which was not incorporated in the Task 38 final report. The text has been changed.

The desired accuracy of a depth-to-bedrock survey for the final establishment of a disposal facility site is 2 to 3 feet, not 10 to 15 feet. For this reason, the seismic refraction method is not recommended.

No change to the text is required.

RESPONSES TO COMMENTS OF RPA DRAFT FINAL REPORT HAZARDOUS WASTE LAND DISPOSAL FACILITY ASSESSMENT

General Comment: The report is a very comprehensive assessment and clearly acknowledges that it is not a Feasibility Study per the requirements of CERCLA. The land disposal facility is simply one alternative to be evaluated in the Feasibility Study context which will include a broad screening of remedial alternatives. Because it is not a Feasibility Study, the report does not address threats to public health and the environment, alternate treatment technologies, and the fact that the land disposal is the least preferred waste management method under the 1984 HSWA. The HSWA landfill disposal restrictions imposed on certain wastes are addressed, however. It is recommended that it be clearly stated in this assessment report that land disposal is not the preferred alternative, and that alternate treatment technologies will be evaluated in the Feasibility Study.

Response:

It is agreed that the hazardous waste land disposal facility assessment is simply one technical alternative within the determination of CERCLA cleanup and feasibility study process. This assessment presents technical, cost, and environmental analyses in support of the CERCLA process of interim actions, RI/FS, and remedial actions.

It is agreed that land disposal is the least preferred waste management method for complete site cleanup. However, it does provide a method for handling both the nonhazardous contaminated soils and solid residues from hazardous waste and CERCLA treatment processes, and as such merits attention to meet the future cleanup needs for the Rocky Mountain Arsenal.

The comprehensive nature of the assessment is due to the multiple purposes that this document was asked to address and the complexity of the RI/FS process for more than 100 potential cleanup sites on one facility. The multiple purposes of this task were to characterize the various wastes potentially requiring land disposal, select a suitable on-site facility with enough detail for a feasibility level estimate of schedule and costs, and estimate schedules and costs for construction and post construction monitoring including site development, operation, closure, and post-closure care. The complexity of the RI/FS process means that assessment of the basic information associated with this feasibility study drives the process to a data intensive investigation. The feasibility studies are part of a process of identifying cleanup choices for numerous sites within RMA. The land disposal facility is a logical alternative, and potentially part of the management of future wastes produced in the cleanup effort rather than the preferred alternative as the primary cleanup technology.

<u>Technical Comments</u>: The following comments/recommendations are offered in the event that the land disposal concept enters the design stage:

Gomment 1: Pages 3-14 and 3-15 (Volume I). Avoidance Area Criterion: It is stated that these include "known contaminated areas".

Comparison with the tricolor maps shows that identified contamination sites are within the land disposal areas under consideration. What effect will this have on the use of clean subsoil for berm construction (page III-4, Volume II)? It is recommended that the report state that soil from contaminated areas would not be used for berm construction.

Response: No effect should occur from these minor potentially contaminated sites, which will be cleaned up before placement of a waste cell on these areas. Enough clean area exists to begin disposal operations and to simultaneously clean up these minor potentially contaminated sites.

The text has been changed to indicate that the clean fill is from uncontaminated areas.

Gomment 2: Pages 4-9. 5-13 and 6-3 (Volume I): Control of storm-water run-on/off is described on these pages. The Colorado Hazardous Waste Regulations (6 CCR 1007-3) specifically state in Part 264.301(c) and (d) that these controls must be able to control run-on/off from the 100-year storm. Was the 100-year storm considered in this preliminary design? Future design should specifically address the 100-year storm.

Response: The assessment did not include detailed design of features relating to handling the 100-year storm. The schemes shown in the report are only conceptual. Detailed design would specifically address the 100-year storm as identified in Section 4.2.2.2, page 4-8.

Comment 3: Pages 5-28 (Volume I) and III-32 (Volume II): On page 5-28 it is stated that "the leachate collection system is assumed to be operated for only the first 30 years of the life of the facility". On page III-32 it is more correctly indicated that one of the requirements of the post closure care period is that the leachate collection and removal system must be operated until leachate is no longer detected. Although the post-closure care period is 30 years, it is important to note that the post closure care period may be extended beyond 30 years from the end of the closure period. In this regard, the statement on page 5-28 is misleading.

Response: The statement from Appendix II page III-32 has been added to the end of the sentence on page 5-28, which now reads: "The leachate collection system is assumed to be operated until leachate is no longer detected."

Page 5-32, last paragraph and Table 5-6 (Volume 1): Some of the Comment 4: calculations presented on Table 5-6 are incorrect, probably as a result of typographical errors. Specifically, "clay barrier soil storage" should be 1.8 inches, not .108 inches. Also, it appears that waste layer "In Situ (saturation)" should be .238 instead of .0238 and "storage capacity" would then be .018. These values would then result in the soil storage and travel time estimates shown on the table (see calculation brief attached to this memo). On page 3-12 it is indicated that a 40-foot depth to water contributes 852 years towards satisfying the 1,000-year isolation criterion. However on Table 5-6 it appears that the 40-foot depth to water contributes 827 years. These values should be consistent with each other. Finally, it is recommended that in the design stage travel time calculations be repeated using site-specific soil data.

Response: The errors in Table 5-6 and page 3-12 have been corrected.

Site-specific soil data would be used in final design; a program for obtaining such data is defined in Appendix V (Volume II).

Comment 5: Page 5-37 (Volume I) and page III-4 (Volume II): On page 5-37 (third paragraph) it is indicated that leachate from the leachate detection layer will be piped to a leachate pond during the post closure care period. On page III-4 it is stated that during operation and post closure care periods contaminated run-off would be trucked and pumped to the leachate treatment pond. Additional information is warranted on this pond in light of the fact that it may be a regulated surface impoundment.

Response: A careful reading of page 5-37, Volume I, shows that the pipe flow is used for leachate transfer after the post closure period. Additional description has been added to reflect leachate pond operation as a regulated surface impoundment.

Comment 6: Volume II. Section I (Waste Characterization) and Section V
(Recommendations for Confirmatory Work): Wastes are
characterized based on the most current information from the
ongoing Remedial Investigation. In Section V it is recommended
that waste compatibilities and liner/waste compatibilities be
evaluated in a testing program. Proposed test methods should
have been included. Also, there is no discussion of, or a
proposal to evaluate waste mobility in the unsaturated zone or
groundwater. Although this is not a specific regulatory
requirement, it is recommended that such an evaluation be
performed in future design studies.

<u>Response</u>: Standard test methods, as recommended by EPA, would be used for waste-to-waste and waste-to-liner compatibility evaluations; testing program design is beyond the scope of this Assessment.

Waste mobility in the unsaturated zone is addressed in Section 5.4.3, Environmental and Public Health Implications, in which deep percolation of leachate is discussed; the discussion does not cover mobility in the groundwater because the travel time of groundwater to the site boundary is probably very short compared to unsaturated zone travel time. The Army has received no response or comments on the Task 27 draft final report from the state of Colorado.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION YNI

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NOV 2 4 1987

Ref: \$HWM-SR

Colonel W. N. Quintrell Program Manager AMXRM-EE Department of the Army U.S. Army Toxic and Hazardous Materials Agency Building 4460 Aberdeen Proving Ground, MD 21010-5401

Re: Rocky Mountain Arsenal (RMA)
Review of Draft Final Report
for Task 27, Hazardous Waste
Land Disposal Facility
Assessment.

Dear Colonel Quintrell:

EPA Region VIII has reviewed the above-referenced draft report. We have two major areas of concern.

This Draft report includes the Army's "preliminary review" of Federal and State "Applicable or Relevant and Appropriate Requirements" (ARAR's). EPA has not yet addressed ARAR's for such a landfill. Further, we have not reviewed this preliminary design for compliance with RCRA landfill design and operation requirements. Ultimately, these landfill requirements will have to be met as ARAR's and their impact be incorporated into the Task 28 Feasibility Study evaluation of alternatives.

Additionally, the assumption of the average annual precipitation rate has been questioned and needs to be reviewed. If in fact the assumption is revised, the implications of precipitation rate will also need revision.

Enclosed please find preliminary comments from our contractors. Our contact in this matter is Mr. Connally Mears at (303) 293-1528.

Sincerely yours,

Robert L. Dupre, Director Hazardous Weste Management Division

Enclosure

David Shelton, CDH cc:

Chris Hahn, Shell Oil Company R. D. Lundahl, Shell Oil Company Thomas Bick, Department of Justice Elliott Laws, Department of Justice Preston Chiaro, EBASCO